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## NEW CHAPTERS IN THE WARFARE OF SCIENCE.

### XVII.—GEOGRAPHY.

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PART II.

3. The Inhabitants of the Earth.—Even while the question of the sphericity of the earth was undecided, another question had been suggested which the Church held to be of far greater importance. The doctrine of the earth's sphericity naturally led to thought upon the tenants of the earth's surface, and another ancient germ idea was warmed into life—the idea of the antipodes—of human beings on the earth's opposite sides.

At this the theological warriors of the Church waxed valiant. Those great and good churchmen determined to fight. To all of them this idea seemed dangerous, to most of them it seemed damnable. St. Basil and St. Ambrose were tolerant enough to allow that a man might be saved who thought the earth inhabited on its opposite sides, but the great majority of the fathers of the Church doubted the possibility of salvation to such misbelievers.

Lactantius asks: "Is there any one so senseless as to believe that there are men whose footsteps are higher than their heads? . . . that the crops and trees grow downward? . . . that the rains and snow and hail fall upward toward the earth? . . . I am at a loss what to say of those who, when they have once erred, steadily persevere in their folly, and defend one vain thing by another."

But a still greater man followed on the same side. St. Augus-

tine seemed inclined to yield a little in regard to the sphericity of the earth, but he fought the idea that men exist on the other side of it, saying that "Scripture speaks of no such descendants of Adam." He insists that men could not be allowed by the Almighty to live there, since if they did they could not see Christ at his second coming descending through the air. But his most cogent appeal, one which we find echoed from theologian to theologian during a thousand years afterward, is to the nineteenth Psalm, and to its confirmation in the Epistle to the Romans; to the words, "Their line is gone out through all the earth, and their words to the end of the world." He dwells with great force on the fact that St. Paul based one of his most powerful arguments upon this declaration regarding the preachers of the gospel, declaring even more explicitly that "verily their sound went into all the earth, their words unto the ends of the world." Henceforth we find it constantly declared that, as those preachers did not go to the antipodes, no antipodes can exist; and therefore that the supporters of this geographical doctrine "give the lie direct to King David and to St. Paul, and therefore to the Holy Ghost." Augustine taught the whole world for over a thousand years that as there was no preaching of the gospel on the opposite side of the earth, there could be no human beings there.

The great authority of Augustine and the cogency of his scriptural argument held the Church, as a rule, firmly against the doctrine of the antipodes; yet that the doctrine continued to have life is shown by the fact that in the sixth century Procopius of Gaza attacks it with a tremendous argument. He declares that if there be men on the other side of the earth, Christ must have come to save them; and, therefore, that there must have been there, as necessary preliminaries to his coming, a duplicate Eden, Adam, Serpent, and Deluge.

Cosmas Indicopleustes also attacked the doctrine with especial bitterness, citing a passage from St. Luke to prove that antipodes are theologically impossible.

At the end of the sixth century comes a man from whom much might be expected—St. Isidore of Seville. He had pondered over ancient thought in science, and, as we have seen, had dared proclaim his belief in the sphericity of the earth; but with that he stopped. As to the antipodes, the authority of the Psalmist, St. Paul, and St. Augustine silences him; he shuns the whole question as unlawful, subjects reason to faith, and declares that men can not and ought not to exist on opposite sides of the earth.*

* For the opinions of Basil, Ambrose, and others, see Lecky, History of Rationalism in Europe, New York, 1872, vol. i, p. 279, note. Also Letronne, in Revue des Deux Mondes, March, 1834. For Lactantius, see citations already given. For St. Augustine's opinion, see the Civ. Dei, xvi, 9, where this great father of the Church shows that the existence of the

Under such pressure this scientific truth seems to have disappeared for nearly two hundred years, but by the eighth century the sphericity of the earth had come to be generally accepted among the leaders of thought, and now the doctrine of the antipodes was again asserted by a bishop, Virgil of Salzburg.

There then stood in Germany, in those first years of the eighth century, one of the greatest and noblest of men—St. Boniface. His learning was of the best then known. In labors he was a worthy successor of the apostles; his genius for Christian work made him unwillingly primate of Germany; his devotion to duty led him willingly to martyrdom. There sat too, at that time, on the papal throne a great Christian statesman — Pope Zachary. Boniface immediately declared against the revival of such a heresy as the doctrine of the antipodes; he stigmatized it as an assertion that there are men beyond the reach of the appointed means of salvation; he attacked Virgil, and called on Pope Zachary for aid.

The Pope, as the infallible teacher of Christendom, makes a strong response. He cites passages from the book of Job and the Wisdom of Solomon against the doctrine of the antipodes; he declares it "perverse, iniquitous, and against Virgil's own soul," and indicates a purpose of driving him from his bishopric. Whether this purpose was carried out or not, the old theological view, by virtue of the Pope's divinely ordered and protected "inerrancy," was re-established, and the doctrine that the earth has inhabitants on but one of its sides became more than ever orthodox, and, in the mind of the Church, necessary to salvation.*

This decision seems to have been regarded as final, and two centuries later the great encyclopedist of the middle ages, Vin-

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antipodes "nulla ratione credendum est." Also citations in Buckle's Posthumous Works, vol. ii, p. 645. For Procopius of Gaza see Kretschmer, p. 55. See also, on the general subject, Peschel, Geschichte der Erdkunde, pp. 96, 97. For Isidore, see citations already given. To understand the embarrassment caused by these utterances of the fathers to scientific men of a later period, see Letter of Agricola to Joachimus Vadianus in 1514. Agricola asks Vadianus to give his views regarding the antipodes, saying that he himself does not know what to do, between the fathers on the one side and the learned men of modern times on the other. On the other hand, for the embarrassment caused to the Church by this mistaken zeal of the fathers, see Kepler's references and Fromund's replies; also De Morgan, Paradoxes, p. 58. Kepler appears to have taken great delight in throwing the views of Lactantius into the teeth of his adversaries.

* For Virgil of Salzburg, see Neander's History of the Christian Church, Torrey's translation, vol. iii, p. 63. Also Herzog, Real. Encyclopaedie, etc., recent edition by Prof. Hauck, *in verb. Virgilius.* Also Kretschmer. See Whewell, i, p. 197; but for best choice of authorities and for most careful winnowing out of conclusions, see De Morgan, pp. 24–26. For very full notes as to pagan and Christian advocates of the doctrine of the sphericity of the earth and of the antipodes, and for extract from Zachary's letter, see Migne, Patrologia, vol. vi, p. 426, and vol. xli, p. 487. For St. Boniface's part, see Bonifacii Epistolæ, ed. Giles, i, 173.

cent de Beauvais, though he accepts the sphericity of the earth, treats the doctrine of the antipodes as utterly disproved. Yet the doctrine still lived. Just as it had been previously revived by William of Conches and then laid to rest, so now it is somewhat timidly brought out in the thirteenth century by no less a personage than Albert the Great, the most noted man of science in that time. But his utterances are perhaps purposely obscure. Again it disappears beneath the theological wave, and a hundred years later Nicolas d'Oresme, Geographer of the King of France, a light of science, is forced to yield to the clear teaching of the Scripture as cited by St. Augustine.

Nor was this the worst. In Italy, at the beginning of the fourteenth century, the Church thought it necessary to deal with questions of this sort by rack and fagot. In 1316 Peter of Abano, famous as a physician, having promulgated this with other obnoxious doctrines in science, only escaped the Inquisition by death; and in 1327 Cecco d'Ascoli, noted as an astronomer, was for this and similar crimes driven from his professorship at Bologna and burned alive at Florence. Nor was this all his punishment: that great painter, Orcagna, whose terrible works still exist on the walls of the Campo Santo at Pisa, immortalized Cecco by representing him in the flames of hell.*

Years rolled on, and there comes in the fifteenth century one from whom the world had a right to expect much. Pierre d'Ailly, by force of thought and study had risen to be Provost of the College of St. Dié in Lorraine; his ability had made that little country village a center of scientific thought for all Europe, and finally made him Archbishop of Cambray and a cardinal. In 1483 was printed what Cardinal d'Ailly had written long before as a summing up of his best thought and research—the collection of essays known as the Ymago Mundi. It gives us one of the most striking examples in history of a great man in theological fetters. As he approaches this question he states it with such clearness that we expect to hear him assert the truth; but there stands the argument of St. Augustine; there, too, stands the biblical texts on

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* For Vincent de Beauvais and the antipodes, see his Speculum Naturales, Book VII, with citations from St. Augustine, De Civitate Dei, cap. xvi. For Albert the Great's doctrine regarding the antipodes, compare Kretschmer as above with Eicken, Geschichte, etc., p. 621. Kretschmer finds that Albert supports the doctrine, and Eicken finds that he denies it—a fair proof that Albert was not inclined to state his views with dangerous clearness. For D'Oresme, see Santarem, Histoire de la Cosmographie, vol. i, p. 142. For Peter of Abano, or Apono, as he is often called, see Tiraboschi; also Ginguené, vol. ii, p. 293; also Naudé, Histoire des Grands Hommes de Magie. For Cecco d'Ascoli, see Montucla, Histoire des Mathematiques, i, 528; also Daunou, Études Historiques, vol. vi, p. 320; also Kretschmer, p. 59. Concerning Orcagna's representation of Cecco in flames of hell, see Renan, Averroes et l'Averroisme, Paris, 1867, p. 328.

which it is founded; the text from the Psalms and the explicit declaration of St. Paul to the Romans, "Their sound went into all the earth, and their words unto the ends of the world." D'Ailly attempts to reason, but he is overawed, and gives to the world virtually nothing.

Still, the doctrine of the antipodes lived and moved: so much so, that the eminent Spanish theologian Tostatus, even as late as the age of Columbus, feels called upon to protest against it as "unsafe." He has shaped the old missile of St. Augustine into the following syllogism: "The apostles were commanded to go into all the world and to preach the gospel to every creature; they did not go to any such part of the world as the antipodes; they did not preach to any creatures there; *ergo*, no antipodes exist."

The warfare of Columbus the world knows well—how the Bishop of Ceuta worsted him in Portugal; how sundry wise men of Spain confronted him with the usual quotations from the Psalms, from St. Paul, and from St. Augustine; how, even after he was triumphant, and after his voyage had greatly strengthened the theory of the earth's sphericity, with which the theory of antipodes was so closely connected, the Church by its highest authority solemnly stumbled and persisted in going astray. In 1493 Pope Alexander VI, having been appealed to as an umpire between the claims of Spain and Portugal to the newly discovered parts of the earth, issued a bull laying down upon the earth's surface a line of demarkation between the two powers. This line was drawn from north to south a hundred leagues west of the Azores; and the Pope in the plenitude of his knowledge declared that all lands discovered east of this line should belong to the Portuguese and all west of it should belong to the Spaniards. This was hailed as an exercise of divinely illuminated power by the Church; but difficulties arose, and in 1506 another attempt was made by Pope Julius II to draw the line three hundred and seventy leagues west of the Cape Verd Islands. This, again, was supposed to bring divine wisdom to settle the question, but shortly overwhelming difficulties arose; for the Portuguese claimed Brazil, and, of course, had no difficulty in showing that they could reach it by sailing to the east of the line, provided they sailed long enough. The lines laid down by Popes Alexander and Julius may still be found upon the maps of the period, but their bulls have quietly passed into the catalogue of ludicrous errors.

Yet the theological barriers to this geographical truth yielded but slowly. Plain as it had become to scholars, they hesitated to declare it to the world at large. Eleven hundred years had passed since St. Augustine had proved its antagonism to Scripture, when Gregory Reysch gave forth his famous encyclopædia, the Margarita Philosophica. Edition after edition was issued, and

everywhere appeared in it the orthodox statements; but they were evidently strained to the breaking point; for, while in treating of the antipodes Reysch refers respectfully to St. Augustine as objecting to the scientific doctrine, he is careful not to cite Scripture against it, and is not less careful to cite geographical reasoning in favor of it.

But in 1519 science gains a crushing victory. Magellan makes his famous voyage. He proves the earth to be round, for his expedition circumnavigates it; he proves the doctrine of the antipodes, for he sees the peoples of the antipodes. Yet even this does not end the war. Many conscientious men oppose the doctrine for two hundred years longer. Then the French astronomers make their measurements of degrees in equatorial and polar regions, and add to their proofs that of the lengthened pendulum. When this was done, when the deductions of science were seen to be established by the simple test of measurement, beautifully and perfectly, and when a long line of trustworthy explorers had sent home accounts of the antipodes, then, and then only, this war of twelve centuries ended.

Such was the main result of this long war; but there were other results not so fortunate. The efforts of Eusebius, Basil, and Lactantius to deaden scientific thought; the efforts of Augustine to combat it; the efforts of Cosmas to crush it by dogmatism; the efforts of Boniface and Zachary to crush it by force, conscientious as they all were, had resulted simply in impressing upon many noble minds the conviction that science and religion are enemies.

On the other hand, what was gained by the warriors of science for religion? Certainly a far more worthy conception of the world and a far more ennobling conception of that Power which pervades and directs it. Which is more consistent with a great religion, the cosmography of Cosmas or that of Isaac Newton? Which presents a nobler field for religious thought, the diatribes of Lactantius or the calm statements of Humboldt? *

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* For D'Ailly's acceptance of St. Augustine's argument, see the Ymago Mundi, Paris, 1490, cap. vii. For Tostatus, see Zöckler, vol. i, pp. 467, 468. He based his opposition on Romans, x, 18. For Columbus, see Winsor, Fiske, and Adams; also Humboldt, Histoire de la Géographie du Nouveau Continent. For the bull of Alexander VI, see Daunou, Études Historiques, vol. ii, p. 417; also Peschel, Zeitalter der Entdeckungen, Book II, chap. iv. The text of the bull is given with the English translation in Arber's reprint of The First Three English Books on America, etc., etc., Birmingham, 1885, pp. 201–204; also especially Peschel, Die Theilung der Erde unter Papst Alexander VI. und Julius II., Leipsic, 1871, pp. 14 *et seq.* For remarks on the power under which the line was drawn by Alexander VI, see Mamiani, Del Papato ne'i Tre Ultimi Secoli, p. 170. For maps showing lines of division, see Kohl, Die beiden altesten General-Karten von Amerika, Weimar, 1860, where maps of 1527 and 1529 are reproduced; also Mercator, Atlas, tenth edition, Amsterdam, 1628, pp. 70, 71. For latest discussion on The Demarkation Line of Alex-

4. THE SIZE OF THE EARTH.—But at an early period another subject in geography had stirred the minds of thinking men—the earth's size. Various ancient investigators had by different methods reached measurements more or less near the truth; these methods were continued into the middle ages, supplemented by new thought, and among the more striking results were those obtained by Roger Bacon and Gerbert, afterward Pope Sylvester II. They handed down to after-time the torch of knowledge, but, as their reward among their contemporaries, they fell under the charge of sorcery.

Far more consonant with the theological spirit of the middle ages was a solution of the problem from Scripture, and this solution deserves to be given as an example of a very curious theological error, chancing to result in great good. The second book of Esdras, which among Protestants is placed in the Apocrypha, was held by many of the foremost men of the ancient Church as fully inspired: though Jerome looked with suspicion on this book, it was regarded as prophetic by Clement of Alexandria, Tertullian, and Ambrose, and the Church acquiesced in that view. In the Eastern Church it held an especially high place, and in the Western Church, before the Reformation, was generally considered by the most eminent authorities to be part of the sacred canon. In the sixth chapter of this book there is a summary of the works of creation, and in this occur the following verses:

"Upon the third day thou didst command that the waters should be gathered in the seventh part of the earth; six parts hast thou dried up and kept them to the intent that of these some, being planted of God and tilled, might serve thee."

"Upon the fifth day thou saidst unto the seventh part where the waters were gathered, that it should bring forth living creatures, fowls and fishes, and so it came to pass."

These statements were reiterated in other verses, and were naturally considered as of controlling authority.

Among the scholars who pondered on this as on all other things likely to increase knowledge was Cardinal Pierre d'Ailly. As we have seen, this great man, while he denied the existence of

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ander VI, see E. G. Bourne in Yale Review, May, 1892. For the Margarita Philosophica, see the editions of 1503, 1509, 1517, lib. vii, cap. 48. For the effect of Magellan's voyages, and the reluctance to yield to proof, see Henri Martin, Histoire de France, vol. xiv, p. 395; St. Martin's Histoire de la Géographie, p. 369; Peschel, Geschichte des Zeitalters der Entdeckungen, concluding chapters; and for an admirable summary, Draper, Hist. Int. Devel. of Europe, pp. 451–453; also an interesting passage in Sir Thomas Browne's Vulgar and Common Errors, Book I, chap. vi. For general statement as to supplementary proof by measurement of degrees and by pendulum, see Somerville, Phys. Geog., chap. i, par. 6, note; also Humboldt, Cosmos, vol. ii, p. 736, and v, pp. 16, 32; also Montucla, iv, 138.

the antipodes as St. Augustine had done, believed firmly in the sphericity of the earth, and, interpreting these statements of the book of Esdras in connection with this belief, he held that, as only one seventh of the earth's surface was covered by water, the ocean between the west coast of Europe and the east coast of Asia could not be very wide. Knowing, as he thought, the extent of the land upon the globe, he felt that in view of this divinely authorized statement the globe must be much smaller, and the land of "Zipango," reached by Marco Polo, on the extreme east coast of Asia, much nearer than had been generally believed.

On this point he laid stress in his great work, the Ymago Mundi, and an edition of it having been published in the days when Columbus was thinking most closely upon the problem of a westward voyage, it naturally exercised much influence upon his reasonings. Among the treasures of the library at Seville, there is nothing more interesting than a copy of this work annotated by Columbus himself; from this very copy it was that Columbus obtained confirmation of his belief that the passage across the ocean to Marco Polo's land of Zipango in Asia was short. But for this error, based upon a text supposed to be inspired, it is unlikely that Columbus would have had the courage to undertake his voyage. It is a curious fact that this single theological error thus promoted a series of voyages which completely destroyed not only this but every other conception of geography based upon the sacred writings.*

5. THE CHARACTER OF THE EARTH'S SURFACE.—It would be hardly just to dismiss the struggle for geographical truth without referring to one passage more in the history of the Protestant Church, for it shows clearly the difficulties in the way of the simplest statement of geographical truth which conflicted with the words of the sacred books.

In the year 1553 Michael Servetus was on trial for his life at Geneva on the charge of Arianism. Servetus had rendered many services to scientific truth, and one of these was an edition of Ptolemy's Geography, in which Judea was spoken of, not as "a land flowing with milk and honey," but, in strict accordance with the truth, as, in the main, meager, barren, and inhospitable. In his trial this simple statement of geographical truth was used

* For this error, so fruitful in discovery, see D'Ailly, Ymago Mundi (my own copy is of 1490); the passage referred to is folio 12 verso. For the passage from Esdras, see chap. vi, verses 42, 47, 50, and 52; see also Zöckler, Geschichte der Beziehungen zwischen Theologie und Naturwissenschaft, vol. i, p. 461. For one of the best recent statements, see Ruge, Gesch. des Zeitalters der Entdeckungen, Berlin, 1882, pp. 221 *et seq.* For the letter of Columbus acknowledging his indebtedness to this mistake in Esdras, see Navarrete, Viajes y Descubrimientos, Madrid, 1825, tome i, pp. 242–264; also Humboldt, Hist. de la Géographie du Nouveau Continent, vol. i, pp. 68, 69.

against him by his arch-enemy John Calvin with fearful power. In vain did Servetus state the fact that he had simply drawn the words from a previous edition of Ptolemy; in vain did he declare that this statement was a simple geographical truth of which there were ample proofs; it was answered that such language "necessarily inculpated Moses, and so grievously outraged the Holy Ghost." *

In summing up the action of the Church upon Geography, we must say, then, that the dogmas developed in the strict adherence to Scripture and the conceptions held in the Church during many centuries "always, everywhere, and by all," were, on the whole, steadily hostile to truth; but it is only just to make a distinction here between the religious and the theological spirit. To the religious spirit are largely due several of the noblest among the great voyages of discovery. A deep longing to extend the realms of Christianity influenced the minds of Prince John, of Portugal, in his great series of efforts along the African coast; of Vasco da Gama, in his circumnavigation of the Cape of Good Hope; of Magellan, in his voyage around the world, and doubtless found a place among the more worldly motives of Columbus.

Thus, in this field also, from the supremacy accorded to theology, we find resulting that tendency to dogmatism which has shown itself in all ages the deadly foe not only of scientific inquiry but of the higher religious spirit itself, while from the love of truth for truth's sake, which has been the inspiration of all fruitful work in science, nothing but advantage has ever resulted to true religion.

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THE Japanese dragon is supposed by Mr. Charles De Kay to be possibly a remnant of the original native religion which was superseded by Buddhism in China and Japan. Compared with the monster as depicted in stone and colors by artists of our middle ages, it is a graceful creature. Dragons a foot or two long, made of an incredible number of pieces held together, are among the marvels of Japanese workers in iron and bronze, and great prices are paid when the foundry-man or ironsmith is a famous artist. The figures sometimes have a character of their own which justifies one in placing them among serious works of art. When taken in the hand their flexibility and coldness make them seem alive; while their singular motions and threatening look express capitally the fierceness and wayward nature attributed to a symbol of the least stable of elements. To us and to skeptical natives the image is a curious, ingenious plaything, but to the Japanese of the old religions or to the Buddhist it means a good deal more: it is a talisman to exorcise the dangers that lie on land and sea.

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* For Servetus's geographical offense, see Willis, Servetus and Calvin, London, 1877, p. 325. The passage condemned is in the Ptolemy of 1535, folio 41. It was discreetly retrenched in a reprint of the same edition. As to the mixture in the motives of Columbus, it may be well to compare with the earlier biographies the recent ones by Dr. Winsor and President Adams.

## THE DELAWARE INDIAN AS AN ARTIST.

By Dr. CHARLES C. ABBOTT.

WHEN a considerable collection of the stone and bone handiwork of the Delaware Indians has been brought together, and with this material before us we picture to ourselves the people in possession of the country when first visited by the Dutch and Swedes, and afterward by the English, the thought arises that considerable importance must be given to a chance remark of Peter Kalm, who spent the winter of 1748–'49 in New Jersey—to wit: "At the first arrival of the *Swedes* in this country, and long after that time, it was filled with *Indians*. But as the *Europeans* proceeded to cultivate the land, the *Indians* sold their land, and went further into the country. But in reality few of the *Indians* really left the country in this manner; most of them ended their days

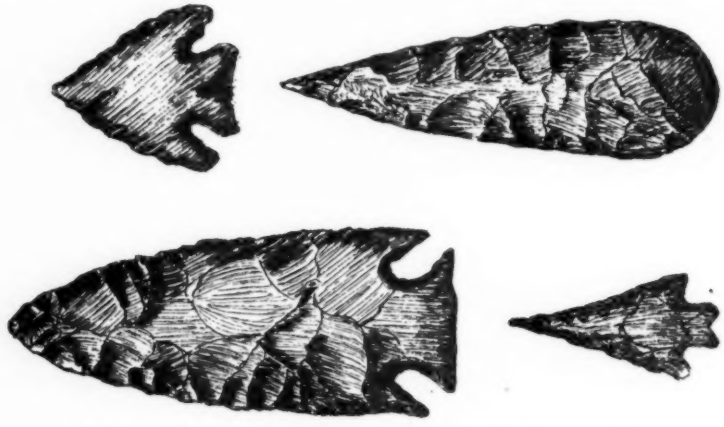

Fig. 1.—Common Forms of Arrow-points from New Jersey.

before, either by wars among themselves, or by the small-pox, a disease which the *Indians* were unacquainted with before their commerce with the *Europeans*, and which since that time has killed incredible numbers of them." Again, our author states: "The *Indians* formerly, and about the time of the first settling of the Swedes, were more industrious and laborious in every branch of business than they are now." In other words, they were not known at their best, even by those who had earliest opportunities of observing them, and what they habitually used and constantly produced, perhaps, but a century or two before the advent of the European, was far superior to their cleverest handiwork in the seventeenth century. The European had to do with a diseased, discouraged, and disappearing people. It is safe to assert that history, as pertaining to the Delaware Valley, would have been

widely different had the European been forced to deal, not with the Lenni Lenâpé as they then were, but as they had been. True, there were statesmen still among them; intellects equal to any with which they had to cope; but the spirit that once seems to have animated the whole nation was broken. The Indians of the seventeenth century were living on the memory of departed glory. Not one of the many writers that have given us an account of what he saw in use among these people, when the Indian still pos-

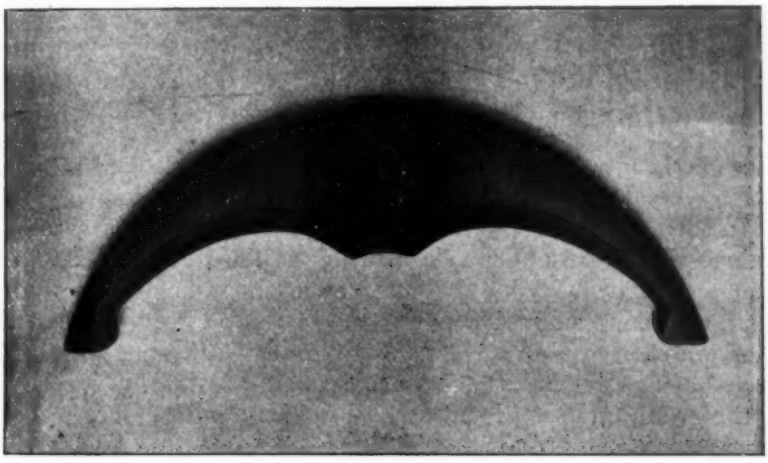

FIG. 2.—STONE CEREMONIAL OBJECT.

sessed the land, refers to many a curious form of stone or bone object, that now for want of knowledge on the subject we call an "ornament," or take refuge behind so convenient a term as "implement." That such objects are full of meaning, could we but decipher it, there is not a doubt.

It is true that, until the products of their handicraft were replaced by similar objects of European manufacture, the Indians were adepts in flint-chipping; made from pebbles shapely axes; carved wooden mortars and even large canoes, and fashioned well-designed pipes both of stone and clay. But what of the far more artistic bird-shaped stones, the so-called ceremonial objects, elaborate gorgets, and even idols? These are found to-day in sufficient numbers to indicate that they were once a prominent if not common feature of every village; but how could they have been overlooked by the Europeans who described their axes and arrow-points, if still in use? They had, it is logical to assume, disappeared from the scene; or, retained, were "relics" in the eyes of their possessors. It is not unwarranted to say, as concerning the Delaware Valley, that when Cornelius Mey discovered the Delaware River, there were Indian "relics" then to be had; and had it

dawned upon the mind of some bright Lenâpé then, he could have gathered, as the antiquities of his own country, objects bearing the same relationship to him that his own axe and arrows do to

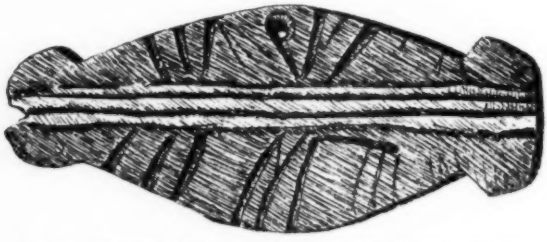

FIG. 3.—ETCHED STEATITE GORGET FROM PENNSYLVANIA.

us. The Indian of 1600 was, at least in some respects, the degenerate descendant of the aborigine of A. D. 1000, or later.

If, then, it may be asked, the Delaware Indians produced, in prehistoric times, objects exhibiting a more advanced culture than did their descendants in historic times or just preceding them, where are such objects now? Has tangible evidence of this assertion been produced? In the Delaware Valley I think it has. There have occasionally been found in single graves, or lying in or on the ground, unassociated articles, clearly of Indian origin, and

FIG. 4.—STONE GORGET. Delaware Indian.

yet not similar to the ordinary "finds" characteristic of Indian village sites. For instance, there have been burial-places examined in this river valley, from which scores of skeletons have been taken, and with them only the most commonplace objects were found,

and many an interment was without any object of stone, bone, or clay. On the other hand, in some lonely spot, some little knoll in a forest, or prominent ridge of earth extending out upon a level meadow tract, a single grave has been found, where objects of a high grade of workmanship and suggesting a distinct advance over the historic Indian occurred. The whole character of the interment was different from that of the average or ordinary Indian grave. There is obvious danger, it is true, from drawing too broad a conclusion from a few such graves. Doubtless the Indian "king" would be interred with greater pomp and with finer possessions than the Indian warrior; but in such instances as I have mentioned, the objects found have been different in character as well as of superior workmanship. In such a matter the best that can be done, with our present stock of knowledge, is to express, tentatively of course, that this or that condition was probably true; and surveying the whole valley, after twenty years of tramp-

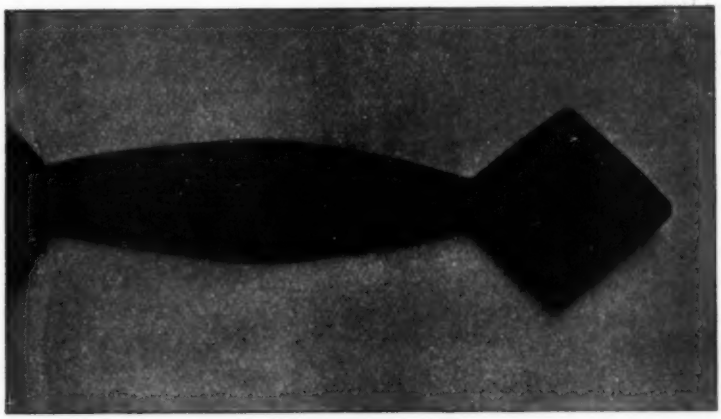

FIG. 5.—HANDLE OF WOODEN SPOON. Modern Chippewa.

ing about it from the mountains to the sea, I have been forcibly impressed with the evidence, first, of man's antiquity in this region, of his gradual progress from a very primitive to a more cultured condition, and of retrogression at the dawn of the historic period.

Much might be said of the skill of the Delaware Indian in all of the many phases of his industry, but I propose only to speak of him as an artist. A love of bright colors was always, and is, a prominent characteristic, and probably the first attempt at personal adornment was the attachment to the person of feathers and small stones of bright hues. Mica and quartz crystals are common in graves. The glitter and glistening of these would be sure to attract. But what of the next step, that of shaping from formless masses objects that strike the fancy of the wearer? To

shape a pebble that it might better meet the needs of a club-head or hatchet called for little skill, and the labor of making an axe has recently been shown to be but slight; but the idea of symmetry was developed and cultivated until a weapon was finally produced that can not be improved upon. The same is true of chipping from flint points for arrow-shafts. A mere splinter of stone, if sharp and narrow, would be as effective as any shape that could be devised; but such chance splinters do not appear to have been used, except directly after the invention of the bow and arrow; and, so far as is now discoverable, a series of artistically designed patterns have been in use for hundreds of years. Fig. 1 represents four arrow-points such as are common everywhere in the valley of the Delaware. The flint-worker who made these had something more than mere utilitarianism in his constitution. A love of the beautiful, of symmetry, of neatness, call it what you will, was well developed. Not one of these would kill a bird or beast one whit quicker than the simple triangular arrow-point; and yet these more elaborate forms are more abundant than those of simpler outline.

I am tempted to suggest that possibly the late (comparatively speaking) use of jasper, here in the valley of the Delaware, may have been generally adopted largely because of the bright colors of that material. Of various tints, and often so veined that even a small object might be partycolored, it is little wonder that the use of jasper became so wide-spread, and argillite in a measure neglected; and yet the latter served every purpose, and from the days of Palæolithic man to the coming of the Dutch and Swedes was never discarded. But argillite is dull gray when old, and never bright or glossy, however newly chipped; while the jasper was red or yellow, green, blue, or variegated, and never lost its brilliancy. Little wonder it was in such demand, and the labor of mining undergone. Its color, doubtless, had much to do with its adoption.

Symmetry, as developed in fashioning the axe and celt, which were pecked and not chipped, as were arrow-points, soon led to the same methods being applied to stone for the production of more elaborately designed objects, and the so-called "ceremonial" forms were made. Fig. 2 represents a nearly faultless example of these common "relics," the purpose of which can only be conjectured. The Indian who shaped this specimen was no "'prentice-hand." He may not have been an artist in the common acceptation of that term; but he needed, to say the least, very little instruction to make him one. Objects of this character are of such remarkable abundance, although seldom of such beauty of finish as is this, that the relic-hunter in his tramps over the fields is continually wondering what they were intended for. I

have found fragments of twenty in one day, and this more than once; but they are not, I think, found in the ordinary clustered graves of the Indians. In single graves, with other odd forms, they have occasionally been found. Fig. 2 is perforated at the middle, and so was intended to be attached to a handle. As a baton-head it would be an attractive object, and, if the staff was further decorated with bright feathers and other trinkets, the whole would be very effective in dance or parade. But what be-

FIG. 6.—STONE ORNAMENT REPRESENTING HUMAN FACE. Susquehanna River, Pa.

came of them all in the days of the first European settlers? Could it be possible they were still in common use, and yet not one writer make mention of them?

But, besides symmetrically shaping stone into ornamental forms, the Delaware Indian was given to ornamenting the smooth surfaces of objects by series of lines and dots, in such regular manner that the eye is pleased. A simple example of this phase of ornamentation is shown in Fig. 3. This is a common gorget, the outline of which is purely fanciful. But it is rendered more attractive by parallel and oblique lines, arranged in a manner that suggests not so much hap-hazard fancy as the highly conven-

tionalized representation of some animal form. This is confirmed, I think, by referring to Fig. 4, which represents another specimen of gorget of most interesting character. The difference between the two is very decided, and yet the relationship is not lost. What, indeed, the figure depicted on this circular gorget is intended for is problematical. That it is animal-like no one will dispute. And with the two gorgets described, both of which are very old and made of stone, compare the illustration here given (Fig. 5) of the handle of a wooden spoon, of very recent date. Here we see the same ornamentation or representation of the same idea. It is scarcely probable that this should have been accidental, and is, further, an exemplification of the expression of an idea by symmetrically arranged lines, and not an effort merely to relieve the monotony of a plain surface.

FIG. 7.—MINIATURE WOODEN MASK. Delaware Indian.

We are now brought to consider realistic representations of familiar objects. The human face is one of these; and whether the Indian first made a few lines and dots to express it, or correctly depicted it, is difficult to determine. It can be made to appear very forcibly, upon a smooth surface, by two dots and two lines, thus: •|•; but did the Indian ever adopt such means? I have never seen it, but Fig. 6 is certainly an approach to

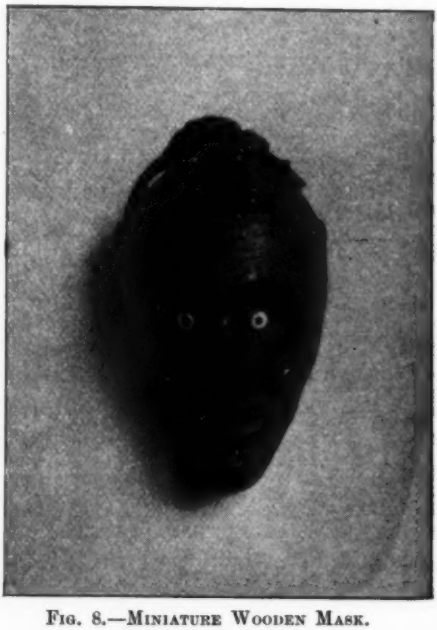

FIG. 8.—MINIATURE WOODEN MASK. Delaware Indian.

such simplicity of illustration. This interesting specimen was recently found on an island in the Susquehanna Valley, and certainly is a most striking example of effective portraiture by means of a few lines and dots.

Having shown how a stone surface was altered to produce either a purely ornamental or a pictorial effect, let me offer now some striking examples of how the artistic efforts of the Indian showed themselves in carving in other substances than stone. This was, of course, a much more difficult matter. Stone is, if not too hard, easily shaped by hammering, its surface yielding to constant hammering with another stone. To shape a bit of wood is another matter, but that the Indian was abundantly capable of this, I offer Fig. 7 as evidence. Here we have an instance of the artist's skill in more than one direction. As we look at the illustration, we see the human face grotesquely represented, and at the same time the portrait is equally good, or almost so, of a barn owl (*Strix pratincola*). To accomplish this the artist must have had a clear conception of many of the rules of his profession.

FIG. 9.—CARVED ANTLER. Delaware Indian.

Fig. 8 brings us, perhaps, to the highest point reached by the Delaware Indians in artistic effort. Here we have a portrait of an Indian, it may be, and at any rate a correct representation of the Indian countenance. This and the preceding, having metal and porcelain about them, were certainly made after European contact, unless we can suppose that the eyes originally were bits of copper, and these becoming detached, were replaced, in one case, with bits of sheet silver, and in the other with small white beads. This is not altogether improbable, and that the objects themselves really antedate the Columbian discovery. They are certainly very old.

Perhaps more striking than either of the wooden carvings is that represented in Fig. 9, which is an example of carved antler, where we have a combination of representations, all realistic, and absolutely perfect in their way. The human face is a marvel of

aboriginal skill. The series of lines and dots are regular, and the faintly outlined snake's tongue is true to nature; as is also the end of the object, which represents with marked fidelity the rattle of the rattlesnake. The Indian who could make this carving had a wide range of capabilities in the line of artistic representation.

And now a word, in conclusion, with reference to pictorial representation, where many objects, and these in action, are concerned. We know how, in recent times, the Western Indian depicted with spirit a fight with other Indians or a buffalo-hunt. If, then, in prehistoric time and at the time of the continent being first peopled with Europeans, our Delaware Indian was capable of such artistic efforts as have been briefly commented upon in the preceding pages, might he not likewise have essayed in this direction also, and recorded events by the grouping of men and animals on slabs of stone? The pictured rocks on the Susquehanna show a disposition to accomplish this on a large scale; but I refer more particularly to ornament gorgets. It is scarcely safe, and certainly not logical, to decry such specimens, however startling the subject treated or artistically accomplished. Perhaps through some such pictured stone we may yet learn that the Indian was present when the last mastodon and giant elk in the valley of the Delaware bit the dust.

## THE DECLINE OF BIBLIOLATRY.*

By Prof. T. H. HUXLEY.

MY memory, unfortunately, carries me back to the fourth decade of the nineteenth century, when the evangelical flood had a little abated and the tops of certain mountains were soon to appear, chiefly in the neighborhood of Oxford; but when, nevertheless, bibliolatry was rampant; when church and chapel alike proclaimed, as the oracles of God, the crude assumptions of the worst informed and, in natural sequence, the most presumptuously bigoted, of all theological schools.

In accordance with promises made on my behalf, but certainly without my authorization, I was very early taken to hear "sermons in the vulgar tongue." And vulgar enough often was the tongue in which some preacher, ignorant alike of literature, of history, of science, and even of theology, outside that patronized by his own narrow school, poured forth, from the safe intrenchment of the pulpit, invectives against those who deviated from his notion of orthodoxy. From dark allusions to

* From the Prologue to Essays upon some Controverted Questions, by T. H. Huxley, F. R. S. New York: D. Appleton & Co., 1892.

"skeptics" and "infidels," I became aware of the existence of people who trusted in carnal reason; who audaciously doubted that the world was made in six natural days, or that the deluge was universal; perhaps even went so far as to question the literal accuracy of the story of Eve's temptation, or of Balaam's ass; and, from the horror of the tones in which they were mentioned, I should have been justified in drawing the conclusion that these rash men belonged to the criminal classes. At the same time, those who were more directly responsible for providing me with the knowledge essential to the right guidance of life (and who sincerely desired to do so), imagined that they were discharging that most sacred duty by impressing upon my childish mind the necessity, on pain of reprobation in this world and damnation in the next, of accepting, in the strict and literal sense, every statement contained in the Protestant Bible. I was told to believe, and I did believe, that doubt about any of them was a sin, not less reprehensible than a moral delict. I suppose that, out of a thousand of my contemporaries, nine hundred at least had their minds systematically warped and poisoned, in the name of the God of truth, by like discipline. I am sure that, even a score of years later, those who ventured to question the exact historical accuracy of any part of the Old Testament and *a fortiori* of the Gospels, had to expect a pitiless shower of verbal missiles, to say nothing of the other disagreeable consequences which visit those who, in any way, run counter to that chaos of prejudices called public opinion.

My recollections of this time have recently been revived by the perusal of a remarkable document,* signed by as many as thirty-eight out of the twenty odd thousand clergymen of the Established Church. It does not appear that the signataries are officially accredited spokesmen of the ecclesiastical corporation to which they belong; but I feel bound to take their word for it, that they are "stewards of the Lord, who have received the Holy Ghost," and therefore to accept this memorial as evidence that, though the Evangelicism of my early days may be deposed from its place of power, though so many of the colleagues of the thirty-eight even repudiate the title of Protestants, yet the green bay tree of bibliolatry flourishes as it did sixty years ago. And, as in those good old times, whoso refuses to offer incense to the idol is held to be guilty of "a dishonor to God," imperiling his salvation.

It is to the credit of the perspicacity of the memorialists that they discern the real nature of the Controverted Question of the age. They are awake to the unquestionable fact that, if Scripture

* Declaration on the Truth of Holy Scripture. The Times, December 18, 1891.

has been discovered "not to be worthy of unquestioning belief," faith "in the supernatural itself" is, so far, undermined. And I may congratulate myself upon such weighty confirmation of an opinion in which I have had the fortune to anticipate them. But whether it is more to the credit of the courage, than to the intelligence, of the thirty-eight that they should go on to proclaim that the canonical Scriptures of the Old and New Testaments "declare incontrovertibly the actual historical truth in all records, both of past events and of the delivery of predictions to be thereafter fulfilled," must be left to the coming generation to decide.

The interest which attaches to this singular document will, I think, be based by most thinking men, not upon what it is, but upon that of which it is a sign. It is an open secret that the memorial is put forth as a counterblast to a manifestation of opinion of a contrary character, on the part of certain members of the same ecclesiastical body, who therefore have, as I suppose, an equal right to declare themselves "stewards of the Lord and recipients of the Holy Ghost." In fact, the stream of tendency toward naturalism, the course of which I have briefly traced, has, of late years, flowed so strongly, that even the Churches have begun, I dare not say to drift, but, at any rate, to swing at their moorings. Within the pale of the Anglican establishment, I venture to doubt, whether, at this moment, there are as many thorough-going defenders of "plenary inspiration" as there were timid questioners of that doctrine half a century ago. Commentaries, sanctioned by the highest authority, give up the "actual historical truth" of the cosmogonical and diluvial narratives. University professors of deservedly high repute accept the critical decision that the Hexateuch is a compilation, in which the share of Moses, either as author or as editor, is not quite so clearly demonstrable as it might be; highly placed divines tell us that the pre-Abrahamic Scripture narratives may be ignored; that the book of Daniel may be regarded as a patriotic romance of the second century B. C.; that the words of the writer of the fourth Gospel are not always to be distinguished from those which he puts into the mouth of Jesus. Conservative but conscientious revisers decide that whole passages, some of dogmatic and some of ethical importance, are interpolations. An uneasy sense of the weakness of the dogma of Biblical infallibility seems to be at the bottom of a prevailing tendency once more to substitute the authority of the "Church" for that of the Bible. In my old age it has happened to me to be taken to task for regarding Christianity as a "religion of a book" as gravely as, in my youth, I should have been reprehended for doubting that proposition. It is a no less interesting

symptom that the state Church seems more and more anxious to repudiate all complicity with the principles of the Protestant Reformation and to call itself "Anglo-Catholic." Inspiration, deprived of its old intelligible sense, is watered down into a mystification. The Scriptures are, indeed, inspired; but they contain a wholly undefined and indefinable "human element"; and this unfortunate intruder is converted into a sort of biblical whipping boy. Whatsoever scientific investigations, historical or physical, prove to be erroneous, the "human element" bears the blame; while the divine inspiration of such statements, as by their nature are out of reach of proof or disproof, is still asserted with all the vigor inspired by conscious safety from attack. Though the proposal to treat the Bible "like any other book," which caused so much scandal forty years ago, may not yet be generally accepted, and though Bishop Colenso's criticisms may still lie, formally, under ecclesiastical ban, yet the Church has not wholly turned a deaf ear to the voice of the scientific tempter; and many a coy divine, while "crying I will ne'er consent," has consented to the proposals of that scientific criticism which the memorialists renounce and denounce.

A humble layman, to whom it would seem the height of presumption to assume even the unconsidered dignity of a "steward of science," may well find this conflict of apparently equal ecclesiastical authorities perplexing—suggestive, indeed, of the wisdom of postponing attention to either until the question of precedence between them is settled. And this course will probably appear the more advisable, the more closely the fundamental position of the memorialists is examined.

No opinion of the fact or form of divine revelation, founded on literary criticism (and I suppose I may add historical or physical criticism) of the Scriptures themselves, can be admitted to interfere with the traditionary testimony of the Church, when that has been once ascertained and verified by appeal to antiquity."*

Grant that it is "the traditionary testimony of the Church" which guarantees the canonicity of each and all of the books of the Old and New Testaments. Grant also that canonicity means infallibility; yet, according to the thirty-eight, this "traditionary testimony" has to be "ascertained and verified by appeal to antiquity." But "ascertainment and verification" are purely intellectual processes, which must be conducted according to the strict rules of scientific investigation, or be self-convicted of worthlessness. Moreover, before we can set about the appeal to "antiquity," the exact sense of that usefully vague term must be

* Declaration, Article X.

defined by similar means. "Antiquity" may include any number of centuries, great or small; and whether "antiquity" is to comprise the Council of Trent, or to stop a little beyond that of Nicæa, or come to an end in the time of Irenæus, or in that of Justin Martyr, are knotty questions which can be decided, if at all, only by those critical methods which the signataries treat so cavalierly. And yet the decision of these questions is fundamental, for as the limits of the canonical Scriptures vary, so may the dogmas deducted from them require modification. Christianity is one thing, if the fourth Gospel, the Epistle to the Hebrews, the pastoral Epistles, and the Apocalypse are canonical and (by the hypothesis) infallibly true; and another thing, if they are not. As I have already said, whoso defines the canon defines the creed.

Now it is quite certain with respect to some of these books, such as the Apocalypse and the Epistle to the Hebrews, that the Eastern and the Western Church differed in opinion for centuries; and yet neither the one branch nor the other can have considered its judgment infallible, since they eventually agreed to a transaction, by which each gave up its objection to the book patronized by the other. Moreover, the "fathers" argue (in a more or less rational manner) about the canonicity of this or that book, and are by no means above producing evidence, internal and external, in favor of the opinions they advocate. In fact, imperfect as their conceptions of scientific method may be, they not infrequently used it to the best of their ability. Thus it would appear that though Science, like Nature, may be driven out with a fork, ecclesiastical or other, yet she surely comes back again. The appeal to "antiquity" is, in fact, an appeal to science, first, to define what antiquity is; secondly, to determine what "antiquity," so defined, says about canonicity; thirdly, to prove that canonicity means infallibility. And when science, largely in the shape of the abhorred "criticism," has done this, and has shown that "antiquity" used her own methods, however clumsily and imperfectly, she naturally turns round upon the appealers to "antiquity," and demands that they should show cause why, in these days, science should not resume the work they did so imperfectly, and carry it out efficiently.

But no such cause can be shown. If "antiquity" permitted Eusebius, Origen, Tertullian, Irenæus, to argue for the reception of this book into the canon and the rejection of that, upon rational grounds, "antiquity" admitted the whole principle of modern criticism. If Irenæus produces ridiculous reasons for limiting the Gospels to four, it was open to any one else to produce good reasons (if he had them) for cutting them down to three, or increasing them to five. If the Eastern branch of the Church had

a right to reject the Apocalypse and accept the Epistle to the Hebrews, and the Western an equal right to accept the Apocalypse and reject the Epistle, down to the fourth century, any other branch would have an equal right, on cause shown, to reject both, or, as the Catholic Church afterward actually did, to accept both.

Thus I can not but think that the thirty-eight are hoist with their own petard. Their "appeal to antiquity" turns out to be nothing but a roundabout way of appealing to the tribunal the jurisdiction of which they affect to deny. Having rested the world of Christian supernaturalism on the elephant of biblical infallibility, and furnished the elephant with standing ground on the tortoise of "antiquity," they, like their famous Hindoo analogue, have been content to look no further; and have thereby been spared the horror of discovering that the tortoise rests on a grievously fragile construction, to a great extent the work of that very intellectual operation which they anathematize and repudiate.

Moreover, there is another point to be considered. It is of course true that a Christian Church (whether the Christian Church, or not, depends on the connotation of the definite article) existed before the Christian Scriptures; and that the infallibility of these depends upon the infallibility of the judgment of the persons who selected the books, of which they are composed, out of the mass of literature current among the early Christians. The logical acumen of Augustine showed him that the authority of the gospel he preached must rest on that of the Church to which he belonged.* But it is no less true that the Hebrew and the Septuagint versions of most, if not all, of the Old Testament books existed before the birth of Jesus of Nazareth; and that their divine authority is presupposed by, and therefore can hardly depend upon, the religious body constituted by his disciples. As everybody knows, the very conception of a "Christ" is purely Jewish. The validity of the argument from the Messianic prophecies vanishes unless their infallible authority is granted; and, as a matter of fact, whether we turn to the Gospels, the Epistles, or the writings of the early Apologists, the Jewish Scriptures are recognized as the highest court of appeal of the Christian.

The proposal to cite Christian "antiquity" as a witness to the infallibility of the Old Testament, when its own claims to authority vanish, if certain propositions contained in the Old Testament are erroneous, hardly satisfies the requirements of lay logic. It is as if a claimant to be sole legatee, under another kind of tes-

* Ego vero evangelio non crederem, nisi ecclesiæ Catholicæ me commoveret auctoritas. —*Contra Epistolam Manichæi*, cap. v. [I would not, indeed, believe the gospel unless the authority of the Catholic Church directed me.—EDITOR.]

tament, should offer his assertion as sufficient evidence of the validity of the will. And, even were not such a circular, or rather rotatory, argument, that the infallibility of the Bible is testified by the infallible Church, whose infallibility is testified by the infallible Bible, too absurd for serious consideration, it remains permissible to ask, Where and when the Church, during the period of its infallibility, as limited by Anglican dogmatic necessities, has officially decreed the "actual historical truth of all records" in the Old Testament? Was Augustine heretical when he denied the actual historical truth of the record of the Creation? Father Suarez, standing on later Roman tradition, may have a right to declare that he was; but it does not lie in the mouth of those who limit their appeal to that early "antiquity," in which Augustine played so great a part, to say so.

Among the watchers of the course of the world of thought, some view with delight and some with horror the recrudescence of supernaturalism which manifests itself among us, in shapes ranged along the whole flight of steps, which, in this case, separates the sublime from the ridiculous—from Neo-Catholicism and Inner-light mysticism, at the top, to unclean things, not worthy of mention in the same breath, at the bottom. In my poor opinion, the importance of these manifestations is often greatly overestimated. The extant forms of supernaturalism have deep roots in human nature, and will undoubtedly die hard; but, in these latter days, they have to cope with an enemy whose full strength is only just beginning to be put out, and whose forces, gathering strength year by year, are hemming them round on every side. This enemy is Science, in the acceptation of systematized natural knowledge, which, during the last two centuries, has extended those methods of investigation, the worth of which is confirmed by daily appeal to Nature, to every region in which the supernatural has hitherto been recognized.

When scientific historical criticism reduced the annals of heroic Greece and of regal Rome to the level of fables; when the unity of authorship of the Iliad was successfully assailed by scientific literary criticism; when scientific physical criticism, after exploding the geocentric theory of the universe, and reducing the solar system itself to one of millions of groups of like cosmic specks, circling, at unimaginable distances from one another, through infinite space, showed the supernaturalistic theories of the duration of the earth and of life upon it to be as inadequate as those of its relative dimensions and importance had been—it needed no prophetic gift to see that, sooner or later, the Jewish and the early Christian records would be treated in the same manner; that the authorship of the Hexateuch and of the

Gospels would be as severely tested; and that the evidence in favor of the veracity of many of the statements found in the Scriptures would have to be strong indeed, if they were to be opposed to the conclusions of physical science. In point of fact, so far as I can discover, no one competent to judge of the evidential strength of these conclusions ventures now to say that the biblical accounts of the creation and of the deluge are true in the natural sense of the words of the narratives. The most the modern reconciler ventures upon is to affirm that some quite different sense may be put upon the words; and that this non-natural sense may, with a little trouble, be manipulated into some sort of non-contradiction of scientific truth.

My purpose, in the essay (XVI)* which treats of the narrative of the Deluge, was to prove, by physical criticism, that no such event as that described ever took place; to exhibit the untrustworthy character of the narrative demonstrated by literary criticism; and, finally, to account for its origin, by producing a form of those ancient legends of pagan Chaldea, from which the biblical compilation is manifestly derived. I have yet to learn that the main propositions of this essay can be seriously challenged.

In the essays (II, III) on the narrative of the Creation, I have endeavored to controvert the assertion that modern science supports, either the interpretation put upon it by Mr. Gladstone, or any interpretation which is compatible with the general sense of the narrative, quite apart from particular details. The first chapter of Genesis teaches the supernatural creation of the present forms of life; modern science teaches that they have come about by evolution. The first chapter of Genesis teaches the successive origin—firstly, of all the plants; secondly, of all the aquatic and aërial animals; thirdly, of all the terrestrial animals which now exist—during distinct intervals of time; modern science teaches that, throughout all the duration of an immensely long past, so far as we have any adequate knowledge of it (that is, as far back as the Silurian epoch), plants, aquatic, aërial, and terrestrial animals have coexisted; that the earliest known are unlike those which at present exist; and that the modern species have come into existence as the last terms of a series, the members of which have appeared one after another. Thus, far from confirming the account in Genesis, the results of modern science, so far as they go, are in principle, as in detail, hopelessly discordant with it.

Yet, if the pretensions to infallibility thus set up, not by the ancient Hebrew writings themselves, but by the ecclesiastical champions and friends from whom they may well pray to be

* [The Roman numerals in this article refer to the author's Essays upon some Controverted Questions.—EDITOR.]

delivered, thus shatter themselves against the rock of natural knowledge, in respect of the two most important of all events, the origin of things and the palingenesis of terrestrial life, what historical credit dare any serious thinker attach to the narratives of the fabrication of Eve, of the Fall, of the commerce between the *Bene Elohim* and the daughters of men, which lie between the creational and the diluvial legends? And, if these are to lose all historical worth, what becomes of the infallibility of those who, according to the later Scriptures, have accepted them, argued from them, and staked far-reaching dogmatic conclusions upon their historical accuracy?

It is the merest ostrich policy for contemporary ecclesiasticism to try to hide its Hexateuchal head—in the hope that the inseparable connection of its body with pre-Abrahamic legends may be overlooked. The question will still be asked, If the first nine chapters of the Pentateuch are unhistorical, how is the historical accuracy of the remainder to be guaranteed? What more intrinsic claim has the story of the Exodus, than that of the Deluge, to belief? If God did not walk in the garden of Eden, how can we be assured that he spoke from Sinai?

In some other of the following essays (IX, X, XI, XII, XIV, XV) I have endeavored to show that sober and well-founded physical and literary criticism plays no less havoc with the doctrine that the canonical Scriptures of the New Testament "declare incontrovertibly the actual historical truth in all records." We are told that the Gospels contain a true revelation of the spiritual world—a proposition which, in one sense of the word "spiritual," I should not think it necessary to dispute. But, when it is taken to signify that everything we are told about the world of spirits in these books is infallibly true; that we are bound to accept the demonology which constitutes an inseparable part of their teaching; and to profess belief in a supernaturalism as gross as that of any primitive people—it is at any rate permissible to ask why? Science may be unable to define the limits of possibility, but it can not escape from the moral obligation to weigh the evidence in favor of any alleged wonderful occurrence; and I have endeavored to show that the evidence for the Gadarene miracle is altogether worthless. We have simply three, partially discrepant, versions of a story, about the primitive form, the origin, and the authority for which we know absolutely nothing. But the evidence in favor of the Gadarene miracle is as good as that for any other.

Elsewhere I have pointed out that it is utterly beside the mark to declaim against these conclusions on the ground of their asserted tendency to deprive mankind of the consolations of the

Christian faith, and to destroy the foundations of morality; still less to brand them with the question-begging, vituperative appellation of "infidelity." The point is not whether they are wicked; but whether, from the point of view of scientific method, they are irrefragably true. If they are, they will be accepted in time, whether they are wicked or not wicked. Nature, so far as we have been able to attain to any insight into her ways, recks little about consolation, and makes for righteousness by very roundabout paths. And, at any rate, whatever may be possible for other people, it is becoming less and less possible for the man who puts his faith in scientific methods of ascertaining truth, and is accustomed to have that faith justified by daily experience, to be consciously false to his principle in any matter. But the number of such men, driven into the use of scientific methods of inquiry and taught to trust them, by their education, their daily professional and business needs, is increasing and will continually increase. The phraseology of supernaturalism may remain on men's lips, but in practice they are naturalists. The magistrate who listens with devout attention to the precept, "Thou shalt not suffer a witch to live," on Sunday, on Monday dismisses, as intrinsically absurd, a charge of bewitching a cow brought against some old woman; the superintendent of a lunatic asylum who substituted exorcism for rational modes of treatment would have but a short tenure of office; even parish clerks doubt the utility of prayers for rain, so long as the wind is in the east; and an outbreak of pestilence sends men not to the churches, but to the drains. In spite of prayers for the success of our arms and *Te Deums* for victory, our real faith is in big battalions and keeping our powder dry; in knowledge of the science of warfare; in energy, courage, and discipline. In these, as in all other practical affairs, we act on the aphorism "*Laborare est orare*";* we admit that intelligent work is the only acceptable worship; and that, whether there be a Supernature or not, our business is with Nature.

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ACCORDING to the London Times, Dr. Frithiof Nansen intends to start on his projected expedition to the north pole next year, and to make direct for the mouth of the Lena River in Siberia. He believes that a current sets from the Siberian coast across the pole to Greenland, as various objects have been discovered on the Greenland coast that could have got there only from Siberia or the sea north of it. Dr. Nansen expects to be away three or four years, but his ship will be provisioned for six years. His V-shaped vessel will be of about two hundred and fifty tons, will accommodate twelve men, and will be so strongly built as to be impervious to ice-nipping. Alcohol will be taken only in the medicine-chest or for food; but apparatus for providing electric light will form part of the equipment.

* [To labor is to pray.—EDITOR.]

# THE MARINE BIOLOGICAL LABORATORY.

By J. S. KINGSLEY.

THE little village of Woods Holl, situated on the southern shore of Massachusetts, just where that long, sandy stretch, known as Cape Cod, begins to jut from the mainland, is one of the most important spots for biological science in the whole of America. And yet how little the summer migrant knows of the place as he passes through it on his way from the mainland to the summer residences of Cottage City and Nantucket! Woods Holl has for the lover of the sea a charming situation. On the south and east is that important water-way, Vineyard Sound, through which is constantly passing a procession of vessels of all styles and sizes, from the tiny cat-boat to the large passenger steamers of the Norfolk and Savannah lines. To the west is the broad and shallow expanse of Buzzard's Bay, with the New Bedford shore now plainly visible, now appearing in that fantastic shape called by the fisherman "looming"—a kind of mirage when the coast appears doubled as in a mirror, and raised some distance above the horizon. To the southwest stretches out the long chain of the Elizabeth Islands, which possess no little interest. They together form the town of Gosnold, named for that old explorer who in 1602 built his fort upon the westernmost island, Cuttyhunk, traces of which are said to remain to the present day. These Elizabeth Isles have retained the musical names which the Indians gave them, and the students who yearly visit Woods Holl have their struggles with the rhyme—

"Naushon, Nashuena,
Nonamesset, Uncatena,
Weepecket, Pasquenese,
Cuttyhunk and Penikese"—

which embodies the names of the eight.

The channels between the islands are known as "gutters," if shallow; "holes," if broad and deep. Thus, in one place is Quick's Hole, in another Robinson's Hole, while between Nonamesset and the mainland is the dangerous passage of Wood's Hole, whose rocks have proved the wreck of many a vessel and which gives the name to the adjacent village, the spelling of which has for some unexplained reason been changed by the Post-Office Department to Holl.*

* [The First Report of the United States Board on Geographic Names has the following explanation of this change: "The name which was originally Wood's Hole was changed several years ago by the summer residents of the place to Woods Holl."—EDITOR.]

The village itself is absolutely without business, except the daily shipment of fresh fish to the Boston and New York markets. In years long gone by, like the neighboring seaports, it was interested in the whale fisheries, and a recollection of those oily days still remains in the old stone candle factory where the spermaceti was made into wax candles. Later the Pacific Guano Company established here its extensive works, to which the phosphate rock of the Carolina rivers was brought, pulverized, treated with sulphuric acid, and converted into fertilizers for the farmer. But a few years ago the company failed, and the property has all been sold.

The United States has considerable interests here. There is the lighthouse wharf, where the supplies for the whole district are kept. To this wharf every buoy and channel-mark is brought each yeár to receive its coat of preservative copper paint; and here is almost always to be seen a reserve light-ship to replace any that may be injured upon the many adjacent shoals. The revenue marine has also its wharf here, where its steamers obtain their supplies of coal and the like. Here, too, is the place where one leaves the dusty cars of the Old Colony Railway for the cool and comfortable steamers for Cottage City and Nantucket. Not these, however, but rather the scientific aspects of the place, interest us at present.

There is no place like the sea-shore for the student of natural history. On the one hand, we can turn to the fields and streams, and find there essentially the same animals and plants which occur a hundred miles inland; on the other, we have the wondrous wealth of life of the ocean, so rich as to almost surpass belief. This richness is of two kinds: First, there is the wealth of numbers, a wealth which is far beyond that of any fresh-water expanse; and, second, the astonishing variety of forms. Whole groups of animals are abundant in the ocean which are absolutely without representatives in our rivers and lakes. Sea anemones and corals, star-fishes and sea-urchins are wholly unknown in fresh water, while thousands of other marine forms have but a few insignificant representatives in ponds and streams.

Nor is this richness either of forms or of individuals the only advantage the sea offers the student. The marine animals often have a greatly different history from their fresh-water relatives. One of the most important studies of the modern naturalist is that which traces every phase of growth of an animal from the time the egg is laid until the adult condition is reached. It is hardly necessary to say that the theory of evolution is no longer a question for discussion with him. He accepts the principle and makes it the key-note of all his investigations. He is now trying to ascertain the various lines of descent, rather than to test the

truth of the theory. One of the laws of evolution is that animals, in their growth from the egg to the adult, pass through conditions which represent, more or less clearly, the different stages through which the line of descent has come. Thus, the existence of rudimentary gills, with the cartilages and blood-vessels proper to gills, in the human embryo, is taken as an indication that at one time the ancestor had gills which were functional—in other words, that man has descended from a fish-like form. There are, however, great differences in the completeness with which this record of ancestral history has been preserved. Speaking generally, more features have been dropped by the fresh-water and terrestrial forms than by those of the sea. In the latter there frequently hatches from the egg a larva which bears not the slightest resemblance to the adult: the young sea-urchin shows not a feature of the spiny creature we find in the holes in the rocks; and these changes—metamorphoses they are called—are fraught with interest and instruction to the student who goes deeper than ascertaining the mere name of the form he collects. So we can see that, if the ocean offer such advantages, a laboratory for the study of Nature should be on the shore.

Not all places on the coast are equally suitable for study. At one there is nothing but sand; another has rocks and no sand or mud; a third has the water vitiated by the mouth of some river constantly pouring in fresh water, which makes the neighboring ocean brackish; a fourth is contaminated by the sewage of a large city. All these conditions conspire to make the region poor in life. The proper place for our studies must have rocky points; stretches of mud and sand exposed at low tide; currents to bring constantly the pure water of the sea; and such localities are not abundant. It was over twenty years ago that the late Professor Spencer F. Baird, of the Smithsonian Institution, recognized the advantages of Woods Holl, not only for the investigation of the problems of pure science, but for the study of the many questions of more economic importance connected with the supply of food-fishes of the country. So, year after year, he and his assistants came here and worked through the summer months. Some made studies of the fish of the region; others collected the other forms of life, for among these we must seek the food of the fishes; still others traced the life-histories of the injurious as well as of the valuable forms; while still others worked at the problems of artificial hatching and the like. As the work went on it outgrew the limited quarters afforded by the barn-like building on the light-house wharf, and so Congress granted the money for the present buildings, the finest for their purposes of any in the world.

These buildings were completed shortly before the death of Professor Baird. On the one side is the Dormitory and Mess Hall,

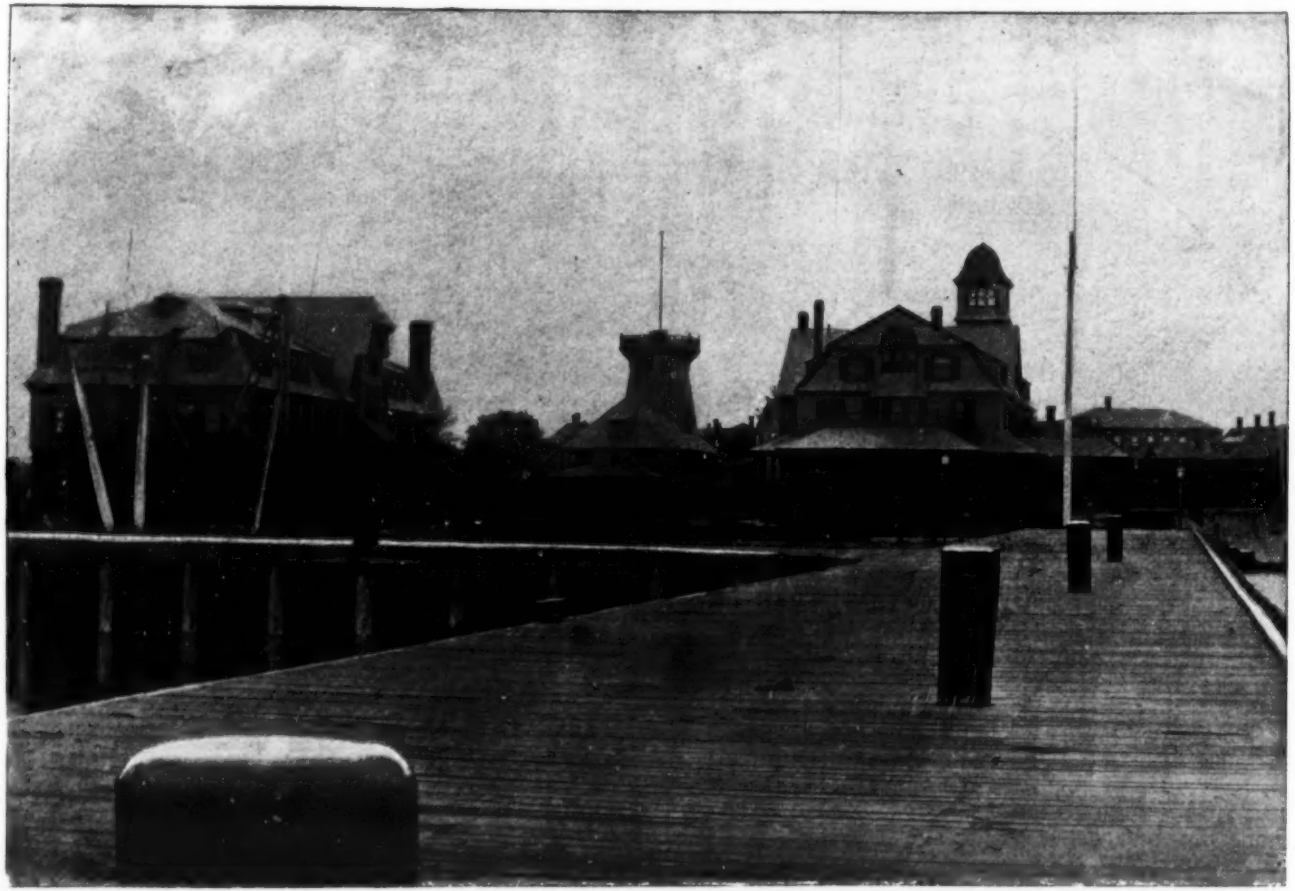

FIG. 1.—BUILDINGS OF THE UNITED STATES FISH COMMISSION, AT WOODS HOLL, MASS. Left, the Laboratory; center, the Engine House; right, the Dormitory. In the background at the right is the building of the Marine Biological Laboratory.

for accommodations are scarce in Woods Holl, and students can not pay summer-hotel prices. On the other is the admirably equipped Laboratory. On the ground-floor is the fish-hatching room, where each year millions of cod, lobsters, and other valuable animals are carried through the critical period of their existence before being turned into the ocean to shift for themselves. On the same floor are the public aquaria stocked with the most interesting and most attractive animals of the region. The second floor is devoted to laboratories for students and offices for the clerical force. Between the dormitory and the laboratory is the pumping station which forces a constant stream of salt water through the aquaria.

Attracted, not only by the natural advantages of the place, but also by the advantages to be gained by proximity to such an institution as the Fish Commission, the Marine Biological Laboratory was located here. This institution is an evolution, and its embryonic history possesses a certain interest.

For several years, Professor Alpheus Hyatt, of the Boston Society of Natural History, with some of his pupils, spent the summer months in natural history studies at the quaint little fishing village of Annisquam, on the north shore of Cape Ann. The facilities afforded, limited as they were, were highly appreciated by those who came, and more than could be accommodated desired each year to profit by them.

One of the many Boston "isms" is its Woman's Education Association, and a world of good it has done. If any scheme can be shown to promise good results for the education of women, the society will see that the money and all that is necessary are soon forthcoming. So with the humble beginnings at Annisquam; if women could be accommodated, the problem could be easily solved. So the Association provided the money, a building was hired and equipped with the absolutely necessary furniture and apparatus, and on June 15, 1881, the first student began his work in the Annisquam Laboratory. For six years this institution was kept up; a hundred students worked there with scalpel and microscope, and the laboratory fully demonstrated its *raison d'être*.

It is a principle of the Woman's Education Association to carry its projects through the experimental stage, but no further. If, then, they have shown their necessity or utility, the Association takes the necessary steps to put the institution upon an independent footing. So with the Annisquam Laboratory. It supplied a want, and must be made permanent. As a result of several meetings in Boston, the Marine Biological Laboratory was incorporated in the spring of 1888, and to it was transferred all the property, etc., of its Annisquam predecessor.

The new was, however, to be greater than the old. At Annis-

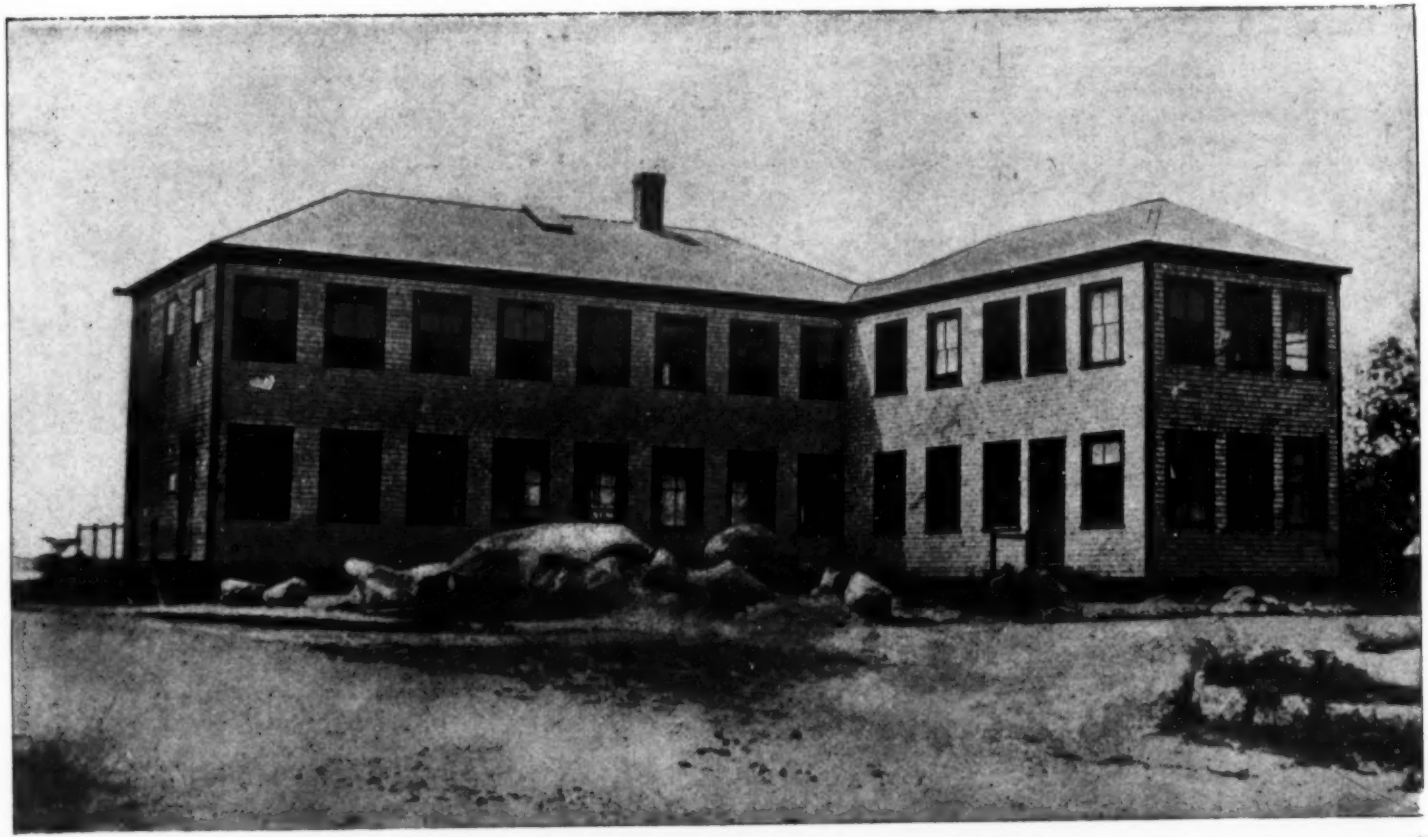

FIG. 2.—BUILDING OF THE MARINE BIOLOGICAL LABORATORY, WOODS HOLL, MASS.

quam instruction had been almost the sole function, and no provision was made for investigation. In the new institution research was to be made prominent. At Annisquam scarce twenty students could be accommodated; its successor must provide for at least fifty. Naturally, the question of situation was a serious one. Not a single place on the whole Atlantic coast, from Eastport to Newport, fulfilled all requirements; but Woods Holl seemed the best of all, and hence the result already indicated.

Money was raised, land near the Fish Commission building was purchased, and a two-story building twenty-nine by sixty-three and a half feet was erected and equipped in time for the summer session of 1888. This was enlarged two years later by an addition measuring twenty by forty feet; and this spring a new addition is being made, equal in size to the original structure. This affords some evidence of the growth of the laboratory, and of the constantly increasing demands upon it for space. This growth is also shown in another way. In 1888, seventeen enjoyed its facilities; in 1889, there was a jump to forty-four; in 1890, forty-seven; while in 1891 there was another jump to seventy-one. In these numbers are included both pupils and instructors, for all are students. Those who do the teaching are always engaged in investigation, and their researches are carried on in the moments snatched from the pupils proper. In 1888 there were but two instructors; for 1892, eight are announced.

The laboratory has been extremely fortunate in its head. Ever since its organization Professor Charles Otis Whitman, of Clark University—recently appointed to the new Chicago University—has served as Director, and not a little of the success of the laboratory is due to his efforts and his plans for its development. The scope of the work as announced for this summer shows how far the laboratory has advanced along the lines laid down for it.

As already mentioned, two very distinct functions are recognized: the laboratory is at once a center for the advancement and for the diffusion of knowledge; it is a school for teaching and an institute for research; and accordingly the students who annually attend are divided by a distinct line into pupils and investigators. In the first category come those whose acquaintance with Nature and with the methods of finding out her secrets, is slight. Before they can engage in original research they must have a solid foundation of fact, and facility in the use of the naturalist's instruments. So they dissect and study under the microscope a selected series of animals and plants which may exhibit broadly the different types of structure in the living world. In this class, to which the ground-floor of the laboratory

is given up, the pupil is constantly under the eye of the instructor, who endeavors to teach him how to use the microscope and its accessories, how to dissect, and, most important of all, how to interpret what he sees. From the animals studied, the young naturalist obtains a broad knowledge of the general structure which occurs in the greater groups of the animal and vegetable worlds, which can be used as a basis for comparison in future work. In giving the necessary instruction, those in charge are continually trying to impress upon the student the necessity of accuracy and the love of truth, and to give him a clear idea of the great principle of homology, which is the very center and soul of modern morphological work.

A word or two may be necessary to explain exactly what this means. Two organs are said to be homologous when they have the same general structure, no matter how diverse may be the uses to which they are put. Thus, for example, if we dissect the arm of a man and the wing of a chicken, we shall find in each similar bones, muscles, blood-vessels, and nerves; in short, a broadly identical structure—they are homologous organs, and yet how different are their functions! On the other hand, when we study the wing of a butterfly or of a bee, we find in it no bones, no muscles, no nerves; and yet it, like the wing of a bird, is an organ of flight. The resemblances are those of analogy; homology is lacking. In these examples the distinctions are evident, but this is not always the case, yet the principle is equally important in all.

These elementary students occupy the ground-floor of the laboratory. Each has his regular seat at the laboratory tables, a locker for his instruments, and his set of reagents and supplies. In the center of the room are the aquaria, where animals for dissection and study are kept. Here he may work "from early dawn to dewy eve," and later if he (or she) desire.

The second floor is dedicated to investigation, and the students here may be divided into two groups. In the first are those who have pursued a course of study essentially equivalent to that of the pupils on the lower floor, and who wish to begin original investigation. It is not an easy problem for the beginner to find out what questions are important to be solved, and even less easy is it for him to attempt their solution. He needs assistance at first at almost every step. For such persons twenty places are provided. The instructors in charge select some problem which needs solution, and which, at the same time, is not too difficult for the beginner, and which, further, will give experience in technique and method of study. They map out the investigation, and watch the embryo investigator in his struggles. Every step in its solution is accompanied with criticism or suggestion, and,

when difficulties arise, either of technique or interpretation, the instructor is at hand to smooth away the trouble.

For those who have passed this preliminary training, and who are ready to carry on investigation, twenty-four private rooms on the second floor are set aside. Here, in privacy and in quiet, undisturbed by others, each can solve his problems. In each room is an aquarium to keep the animals or plants, while the table and shelves are supplied with the necessary books, reagents, and glassware. All who have carried on investigations after the modern methods of zoölogy and botany realize that rapidity is incompatible with good work. A thorough piece of investigation can not be completed in a few weeks; and yet over thirty papers have been published, or are now in press, as the results of the in-

FIG. 3.—A BIT OF THE STUDENTS' LABORATORY, WOODS HOLL, MASS.

vestigations carried on in those private rooms. No laboratory connected with any college or university in the country can show equal productiveness.

In both upper and lower laboratories, among both beginners and investigators, some are working at zoölogical, others at botanical subjects; while this year, for the first time, physiology is to be included in the work done. Material for study is abundant. Besides row-boats, which are available for shore collecting, the laboratory has a sail-boat and also a Burgess-built steam-launch, the Sagitta, which has proved itself the fastest boat in the region. This is daily in use. Now it goes out on a dredging trip in the sound; yesterday it made a trip to Cuttyhunk or Gay Head for lobsters; this morning it made the round of the fish-pounds

along the coast for sharks and strange fish; to-morrow it will take a party to Naushon for worms and sea-cucumbers. So it goes, day after day, constantly bringing material for the workers in the laboratory. At night another kind of collecting is tried. Many of the smaller animals and the larvæ of the larger kinds come to the surface of the sea when the sky is dark and the water calm. Then the naturalist, with a net of gauze, skims the surface of the sea, and catches the life found there. The results of such surface-skimming are wonderful, and no one who has never seen the operation would begin to imagine the richness of the catch. And then, how quickly it dies! At night there are millions of animals in the dishes into which the tow is poured; in the morning all are dead. So the skimmings must be studied soon after they are taken, if one wishes to utilize them.

The instruction given at the laboratory is largely personal. Each student is carefully watched by the instructors, and naturally the beginners receive more attention than those in the upper laboratory. They also have their daily lectures upon the general principles of zoölogy and botany. There are frequently other laboratory lectures upon subjects of more general scientific interest. These are given in the evening by the laboratory staff or by visiting naturalists, and no lecture course in the country can boast of such subjects treated by such masters. Naturally, they are appreciated by all, and the little lecture-room is always crowded when they occur. The lectures for 1890 have been issued in book-form, and the volume has been highly praised by the scientific press of the world.

To the student of to-day books are almost as important as specimens. He needs them to show him not only what has already been found out, so that he need not waste his time in duplicating the labors of some foreign naturalist, but also to show him the structure or development in allied forms, so that with the larger array of facts he can have a basis for interpretation of the meaning of his own discoveries. So the laboratory has gathered together a small library. Most of the publishing naturalists of America have given extra copies of their papers, and a generous friend has supplied the means for the purchase of complete sets of several of the most important European periodicals.

Although started in Boston, the Marine Biological Laboratory is a national rather than a local institution. A student from California is as warmly welcomed as one from the immediate neighborhood. In its four years students have come from twenty-two States, from Canada and Japan. Philadelphia has sent more students than Boston; while Dakota, Nebraska, Colorado, California, and Kansas have been represented. The fees charged are, for the lower laboratory, thirty dollars; for the upper, fifty dol-

lars, for the season. These fees fall far short of paying the actual running expenses, and yet every outgo is reduced as far as is compatible with first-class results. So every year the trustees have the problem of meeting the deficiency. So far it has been successfully solved, but it means a continuous struggle. Various plans have been suggested; the most promising is the following: That different colleges and universities endow the private rooms with a hundred dollars a year, and by virtue of this payment have the right to nominate the annual occupant.

Such in outline is the Marine Biological Laboratory as it exists to-day; but it is far from being the institution that its friends

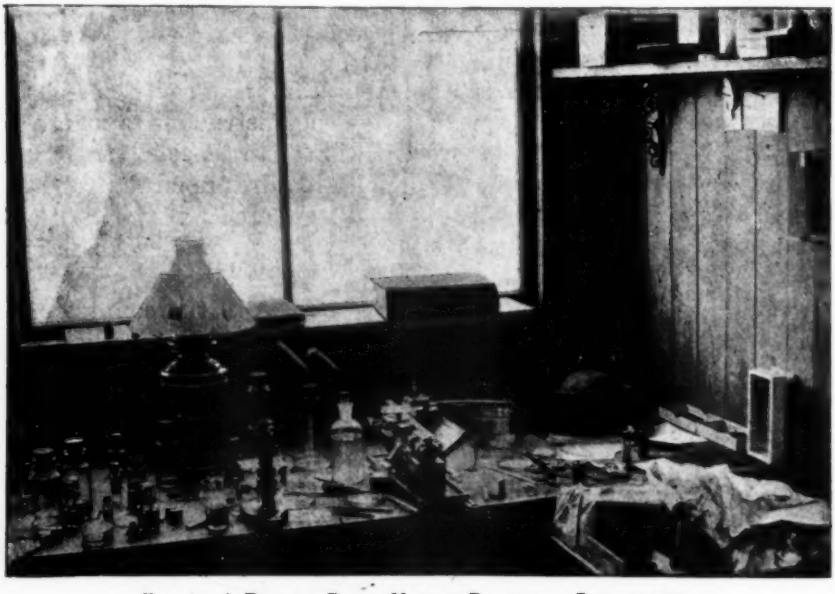

FIG. 4.—A PRIVATE ROOM, MARINE BIOLOGICAL LABORATORY.

wish it to be. It has developed about as far as possible in the line of a school of instruction, but as a center of investigation there is a chance for enormous growth, and for development in that direction the plans are already well thought out, but as yet the necessary money is lacking.

Only a few years ago, when the student wished to investigate marine life, he must take his laboratory with him and depend for quarters upon a room in a fish-house or the like near the shore. That was the way in which Johannes Müller worked in Europe, and the way in which Agassiz studied on our own coast. Some fifteen or twenty years ago the change began, and sea-side laboratories were erected. The best known of these to-day is the celebrated Zoölogical Station at Naples, established by Dr. Dohrn, to which students flock from every quarter of the world. In its

appointments it is almost perfect, while in its results it takes the first rank of all the institutions of investigation in existence. Since its establishment other laboratories modeled after it have been founded in all quarters of the globe—Australia, Japan, and Java not being behind the rest. In America the station established by Mr. Alexander Agassiz at Newport is exclusively for investigation, but it is only open to invited guests of its founder. It was a part of the plan of the late Professor Baird to make the Woods Holl station of the United States Fish Commission a center of pure science as well as a laboratory for the solution of the more economic problems connected with the food-fishes, and it has been such. The scientific results published by the students who have availed themselves of the facilities afforded have been very considerable. Still, it is evident that in a Government institution research must ever be subordinate to the more practical questions. The people can pay for that which will put dollars in their pockets, but study for study's sake is something that the average politician can not appreciate. At present, at least, pure research must be supported by private means rather than by Government grant.

The Marine Biological Laboratory has the foundation upon which the ideal laboratory can be built. Its board of trustees includes some of the most prominent zoölogists in America, who can be expected to guide it in the most profitable directions. It has already purchased land for future growth. The desire now is that upon this land shall be erected a building which can be kept open all the year, instead of some three or four months in summer. Here there shall be a force of paid investigators through the year, working at the many problems connected with the living world. On the other hand, it will at the same time prove an annex to every progressive college and university in the land, for to it in summer both professors and students can freely come for study and to collect the materials for the winter classes. It will need a large library for reference, and funds for the publication of the results worked out within its walls.

Such an institution can not live from hand to mouth, but it must have an endowment sufficient to pay all running expenses, salaries, and the like. It offers to the future benefactor much in return. To found a college or university to-day requires an enormous fortune; a fraction of that sum would establish a biological station the best in the world. Nowhere in educational lines can such great results be expected as here. We have enough colleges and universities; institutions primarily for research are as yet lacking; yet what honor they would reflect upon the man farsighted and public-spirited enough to give them the means of existence!

# INFECTIOUS DISEASES. CAUSATION AND IMMUNITY.*

By GEORGE M. STERNBERG, M. D.,
SURGEON UNITED STATES ARMY.

CERTAINLY, from a scientific point of view, no question in medicine is more important than that which relates to the causation of disease. An accurate knowledge of the specific etiological agents concerned in the production of specific infectious diseases forms the very basis of scientific medicine; and, as you all know, researches which have been made during the past thirty years have given us this accurate knowledge for a considerable number of these diseases. I say thirty years, in order to include the researches of Davaine upon anthrax; but, as a matter of fact, the principal portion of our knowledge relating to specific disease-germs has been acquired during the past decade.

As an introduction, a brief historical review of the progress of our knowledge will perhaps not be out of place. But first I must call your attention to the fact that this progress has been made possible by certain improvements in methods of research, and especially by the following: first, the use of a cotton filter to exclude atmospheric organisms from our culture media (Schröder and Von Dusch, 1854); second, the sterilization of culture media by heat (methods perfected by Pasteur, Koch, and others); third, the use of aniline dyes as staining agents (first recommended by Weigert in 1877); fourth, the introduction of solid culture media, and the "plate method" for obtaining pure cultures (by Koch in 1881); fifth, the perfection of methods for cultivating anaërobic bacteria. I have already referred to the researches of Davaine relating to the disease of cattle and sheep known as anthrax. Having ascertained that the blood of an infected animal constantly contained a rod-shaped micro-organism, and that the smallest quantity of this blood inoculated into a susceptible animal gave rise to the disease and caused its death, Davaine, in 1863, boldly announced his belief that the bacillus was the specific etiological agent in this disease. The experiments of Davaine were not, however, generally accepted as conclusive, because, in inoculating an animal with blood containing the bacillus, the living micro-organism was associated with material from the body of the diseased animal. This objection was subsequently removed by the experiments of Pasteur, Koch, and many others with pure cultures of the bacillus. These were shown to have the same pathogenic effects as had been obtained in inoculation experiments with the

* Address in Medicine, delivered at Yale University, June 28, 1892.

blood of an infected animal. To-day no one questions the etiological relation of *Bacillus anthracis* to the disease anthrax. And this bacillus has served for innumerable experiments relating to the solution of a variety of questions in pathology and preventive medicine. Among these we may mention the following, each of which has an extended literature: attenuation of virulence; protective inoculation of susceptible animals; hereditary transmission of protection; passage of pathogenic bacteria through the placenta, from the mother to the fœtus; explanation of acquired immunity; comparative value of germicidal agents and of antiseptics; conditions governing spore formation, etc.

Proceeding with our historical review: In 1873, Obermeier, a German physician, announced the discovery, in the blood of patients suffering from relapsing fever, of a minute, spiral, actively motile micro-organism—the *Spirochæte Obermeieri*—which is now generally recognized as the specific infectious agent in this disease. Recently (1890) a spirillum closely resembling the relapsing-fever spirillum has been discovered by Sakharoff, a Russian investigator, in the blood of geese. The investigations of the author named show that it is the cause of a fatal epidemic disease which occasionally prevails among geese in certain swampy localities in Caucasia.

In 1879 Hansen reported the discovery of bacilli in the cells of leprous tubercles. Subsequent researches have shown that this bacillus is constantly associated with leprosy, and presumably bears an etiological relation to the disease.

In the same year (1879) Neisser discovered the "gonococcus." The bacillus of typhoid fever was first observed by Eberth, and independently by Koch, in 1880, but it was not until 1884 that Gaffky's important researches relating to this bacillus were published. It is now well established that this bacillus is constantly found in the spleen and intestinal glands involved in cases of typhoid fever; and pathologists have generally accepted it as the specific etiological agent in this disease. We can scarcely doubt the correctness of this conclusion, although it must be admitted that no satisfactory experimental demonstration of the fact has yet been made, inasmuch as none of the lower animals are subject to the disease as it occurs in man, and inoculations with pure cultures do not give rise to identical morbid phenomena. Since the discovery of the typhoid bacillus very numerous researches have been made to determine in an exact manner its biological characters, its resistance to germicidal agents, the duration of its vitality in drinking-water and in the soil, its presence in water the ingestion of which has been suspected of causing typhoid fever in man, etc. As to the results of these investigations we may say, in brief, that it has been shown that the

bacillus as obtained from the spleen of typhoid cadavers varies somewhat in different cases; that very similar bacilli may be obtained from waters contaminated by sewage, etc., which differ from the typhoid bacillus in certain characters of growth, and yet resemble it so closely that it is still uncertain whether they are to be considered distinct species or only varieties of the typhoid bacillus; that the character which was at first supposed to distinguish the typhoid bacillus from all others—viz., its invisible growth upon potato—has proved to be unreliable, inasmuch as certain other bacteria have been shown to have a like invisible growth, and under certain circumstances the typhoid bacillus may form a visible growth on potato. However, in spite of these difficulties in differentiating the typhoid bacillus from nearly allied bacteria found in water or in the dejecta of man and the lower animals, there is good reason to believe that the bacillus of Eberth, of Koch, and of Gaffky is the veritable etiological agent in the widely spread endemic and sometimes epidemic disease known as typhoid fever. But in admitting this we must admit that the bacillus itself is widely distributed, and that an attack of typhoid fever does not necessarily follow its introduction into the alimentary canal of man by means of contaminated water or milk. Other secondary causes, no doubt, often determine the question of infection. Among these we may mention individual susceptibility; exposure to agencies which reduce the vital resisting power, such as sewer-gas poisoning; the quantity and the virulence of the typhoid germs ingested; the state of the digestive function, etc.

In 1880 the present writer discovered the important pathogenic micrococcus which is now generally recognized as the usual cause of croupous pneumonia. This I now call *Micrococcus pneumoniæ crouposæ*. The German bacteriologists usually speak of it as the *Diplococcus pneumoniæ*. I first discovered this micrococcus in the blood of rabbits inoculated with a few drops of my own saliva; and subsequent researches have shown that it is found in the saliva of healthy individuals in various parts of the world. This fact may at first view appear to be opposed to the statement that it is the usual cause of croupous pneumonia, especially as I have never myself suffered from this disease, although for several years I frequently demonstrated the presence of this micrococcus in my salivary secretions. But, as in the case of the typhoid bacillus and several other widely distributed bacteria, while accepting, upon experimental evidence, the etiological relation of the specific micro-organism, we are also obliged to admit the essential relation of predisposing or exciting causes in the development of an attack of the disease. In this connection I quote from a paper of my own, published in 1885:

The constant presence of this micrococcus in the buccal secretions of healthy persons indicates that some other factor is required for the development of an attack of pneumonia; and it seems probable that this other factor acts by reducing the vital resisting power of the pulmonary tissues, and thus making them vulnerable to the attacks of the microbe. This supposition enables us to account for the development of the numerous cases of pneumonia which can not be traced to infection from without. The germ being always present, auto-infection is liable to occur when, from alcoholism, sewer-gas poisoning, crowd-poisoning, or any other depressing agency, the vitality of the tissues is reduced below the resisting point. We may suppose, also, that a reflex vaso-motor paralysis, affecting a single lobe of the lung, for example, and induced by exposure to cold, may so reduce the resisting power of the pulmonary tissues as to permit this micrococcus to produce its characteristic effects. Again, we may suppose that a person, whose vital resisting power is reduced by any of the causes mentioned, may be attacked by pneumonia from external infection with material containing a pathogenic variety of the micrococcus having a potency, permanent or acquired, greater than that possessed by the same organism in normal buccal secretions."

Investigations made since the above was written show that this micrococcus does vary greatly in its pathogenic power when obtained from different sources, and that virulent cultures obtained from the blood of inoculated animals become attenuated when they are kept for a short time. This, indeed, is a general rule as regards the best-known pathogenic bacteria; which usually acquire increased virulence when cultivated in the bodies of susceptible animals, and become attenuated as regards their pathogenic potency when they are cultivated for a certain length of time in artificial media. My own experiments with pneumonic sputum were made in January, 1885, and led me to the identification of the oval coccus, commonly in pairs, which is found in this material, with the coccus which I had previously found in my own saliva (September, 1880), and which was subsequently the object of extended experimental researches made by me in 1881–1884.

In my paper read before the Pathological Society of Philadelphia, in April, 1885, I say: "It seems extremely probable that this micrococcus is concerned in the etiology of croupous pneumonia. . . . But this can not be considered as definitely established by the experiments which have thus far been made upon the lower animals." The extended researches of Fränkel, Weichselbaum, Netter, Gamaleïa, G. and F. Klemperer, and others, which have been published since, have fully established the etiological *rôle* of the micrococcus in question.

In 1882 Fehleisen isolated the so-called streptococcus of erysipelas and proved by experiment that it is the etiological agent in the production of erysipelatous inflammations. At a later date (1884) Rosenbach isolated the micro-organisms commonly concerned in traumatic infections and in the production of acute abscesses. Among these was a streptococcus, called by him *Strep-*

*tococcus pyogenes*, which is probably identical with *Streptococcus erysipelatos* of Fehleisen, although some bacteriologists still insist that slight differences exist in the mode of growth in certain culture media which justify the view that they are well-defined varieties if not distinct species. I am of the opinion that the streptococcus obtained from erysipelatous inflammations is identical with the streptococcus of pus; and we have ample evidence that the pathogenic power of this micro-organism differs as a result of conditions relating to its environment. In artificial culture media it becomes more or less attenuated, but when obtained from the tissues invaded in erysipelas, or in puerperal septicæmia, it has an increased virulence. Like the micrococcus of pneumonia, this is a widely distributed micro-organism; it has frequently been obtained in cultures from the surface of the body or from exposed mucous membranes of healthy persons. This is also true of the other pus cocci concerned in traumatic infections. And, in the light of our present knowledge, it appears that erysipelas, wound infection, abscess formation, etc., do not depend alone upon the presence of the specific etiological agents which induce such localized infectious processes, but also upon predisposing and secondary causes relating to the infected individual, as well as upon the origin and virulence of the pathogenic micro-organism. Thus the *Streptococcus pyogenes* from a case of erysipelas or of puerperal septicæmia introduced into a recent wound upon a healthy person would be likely to cause a severe and possibly fatal infection, while an attenuated culture of the same would perhaps give rise to no symptoms, or at most to slight local inflammation. On the other hand, if the vital resisting power of the individual is reduced by previous ill-health, by insufficient food, by sewer-gas poisoning, crowd-poisoning, etc., an attenuated variety of *Streptococcus pyogenes* may perhaps give rise to an erysipelatous inflammation, or to an acute abscess, if introduced by accident into an open wound. Again, in contused and lacerated wounds the vital resisting power of the tissues is diminished; and wound infection is likely to occur from the accidental introduction of the pus cocci, which lead a saprophytic existence upon the surface of the body and exposed mucous membranes, where under ordinary circumstances they are quite harmless. Secondary infections due to these now well-known pyogenic micrococci are not infrequent as sequelæ to the specific infectious diseases, such as scarlet fever, yellow fever, etc.

In 1882 Koch published his famous discovery of the tubercle bacillus. This will always rank as one of the most important events in the history of medicine, and as a notable triumph of well-directed scientific research. The proof that the bacillus referred to is the specific cause of tuberculous processes and that

tuberculosis is an infectious disease, was contained in Koch's original memoir announcing his discovery. Investigations made since have fully confirmed Koch's conclusions in all important particulars. In order to show you the interest taken by bacteriologists and pathologists in all that relates to the tubercle bacillus and the effects of its pathogenic action, I have referred to the Jahresbericht of Baumgarten, for the year 1890, which gives abstracts of all original memoirs in this field of research. The total number of papers referred to, published during the year mentioned, is one hundred and thirty-five. By far the greater number are published in German and French journals, but the literature includes a certain number of memoirs published in Russia, in Italy, in Hungary, in Sweden, and in the United States.

Another important discovery, made in 1882, is that of the bacillus of glanders, by Löffler and Schutz.

Koch published his discovery of the cholera spirillum ("comma bacillus") in 1884.

The same year (1884) Löffler discovered the diphtheria bacillus. Subsequent researches have not only established the etiological relation of this bacillus to the disease known as diphtheria, but have given us an exact knowledge of its biological characters and pathogenic action, as tested upon lower animals.

The tetanus bacillus was discovered in 1884 by Nicolaier, a student in the laboratory of Prof. Flügge, of Göttingen. That this bacillus is the cause of tetanus in man has been demonstrated by the subsequent researches of numerous investigators.

So far as human pathology is concerned, no important pathogenic micro-organism has been discovered since the date last mentioned (1884) until the present year. After numerous unsuccessful researches by competent bacteriologists, a bacillus has been discovered by Pfeiffer, of Berlin, and independently by Canon, which there is good reason to believe is the specific cause of epidemic influenza.

We have, also, a recent announcement, by Canon, of the discovery of a minute bacillus in the blood of patients suffering with measles, but the etiological relation of this bacillus has not been established, and additional researches will be required before we can properly estimate the value of Canon's alleged discovery.

The brief historical review which we have made shows that the etiology of a considerable number of infectious diseases has been determined by the researches of bacteriologists, but it also shows that other important diseases of this class are not included in this list.

Up to the present date no satisfactory demonstration of the specific infectious agent has been made in any one of the eruptive fevers; and in yellow fever, my own extended researches have

failed to clear up the etiology of the disease. In the last-mentioned disease, there are excellent *a priori* reasons for believing that a living micro-organism of some kind is the essential etiological factor; but this hypothetical germ has eluded all researches. Possibly it belongs to an entirely different class of micro-organisms, as is the case with the blood parasite which is now recognized as the cause of the malarial fevers.

Having thus briefly reviewed the progress of our knowledge relating to the etiology of infectious diseases, I desire to call your attention to the question of acquired immunity from these diseases.

No questions in general biology are more interesting, or more important from a practical point of view, than those which relate to the susceptibility of certain animals to the pathogenic action of certain species of bacteria, and the immunity, natural or acquired, from such pathogenic action which is possessed by other animals. It has long been known that certain infectious diseases, now demonstrated to be of bacterial origin, prevail only or principally among animals of a single species. Thus, typhoid fever, cholera, and relapsing fever are diseases of man, and the lower animals do not suffer from them when they are prevailing as an epidemic. On the other hand, man has a natural immunity from many of the infectious diseases of the lower animals, and diseases of this class which prevail among animals are frequently limited to a single species. Again, several species, including man, may be susceptible to a disease, while other animals have a natural immunity from it. Thus, tuberculosis is common to man, to cattle, to apes, and to the small herbivorous animals, while the carnivora are, as a rule, immune; anthrax may be communicated by inoculation to man, to cattle, to sheep, to guinea-pigs, rabbits, and mice, but the rat, the dog, carnivorous animals, and birds are generally immune; glanders, which is essentially a disease of the equine genus, may be communicated to man, to the guinea-pig, and to field-mice, while house-mice, rabbits, cattle, and swine are to a great extent immune.

In addition to this general race immunity or susceptibility, we have individual differences in susceptibility or resistance to the action of pathogenic bacteria, which may be either natural or acquired. As a rule, *young animals are more susceptible than older ones.* Thus in man the young are especially susceptible to scarlet fever, whooping-cough, and other "children's diseases," and after forty years of age the susceptibility to tubercular infection is very much diminished. Among the lower animals it is a matter of common laboratory experience that the very young of a susceptible species may be infected when inoculated with an "attenuated culture" which older animals of the same species are able to resist.

Considerable differences as to susceptibility may also exist among adults of the same species. In man these differences in individual susceptibility to infectious diseases are frequently manifested. Of a number of persons exposed to infection in the same way, some may escape entirely, while others have attacks differing in severity and duration. In our experiments upon the lower animals we constantly meet with similar results, some individuals proving to be exceptionally resistant. Exceptional susceptibility or immunity may be to some extent a family characteristic, or one of race. Thus, the negro race is decidedly less subject to yellow fever than the white race, and this disease is more fatal among the fair-skinned races of the north of Europe than among the Latin races living in tropical or subtropical regions. On the other hand, small-pox appears to be exceptionally fatal among negroes and dark-skinned races generally. A very remarkable instance of race immunity is that of Algerian sheep against anthrax, a disease which is very fatal to other sheep.

The essential difference between a susceptible and immune animal depends upon the fact that in one the pathogenic germ, when introduced by accident or experimental inoculation, multiplies and invades the tissues or the blood, where, by reason of its nutritive requirements and toxic products, it produces changes in the tissues and fluids of the body inconsistent with the vital requirements of the infected animal; while in the immune animal multiplication does not occur or is restricted to a local invasion of limited extent, and in which after a time the resources of Nature suffice to destroy the parasitic invader.

Now, the question is, Upon what does this essential difference depend? Evidently upon conditions favorable or unfavorable to the development of the pathogenic germ; or upon its destruction by some active agent present in the tissues or fluids of the body of the immune animal; or upon a neutralization of its toxic products by some substance present in the body of the animal which survives infection. The composition of the body fluids, and especially their reaction, is probably a determining factor in some instances. Thus, Behring has ascribed the failure of the anthrax bacillus to develop in the white rat, which possesses a remarkable immunity against anthrax, to the highly alkaline reaction of the blood and tissue juices of this animal. Behring claims to have obtained experimental proof of the truth of this explanation by feeding white rats on an exclusive vegetable diet, or by adding acid phosphate of lime to their food, by which means this excessive alkalinity of the blood is diminished. Rats so treated are said to lose their natural immunity, and to die as a result of inoculation with virulent cultures of the anthrax bacillus.

The recent experiments of Nuttall, Behring, Buchner, and others have established the fact that recently drawn blood of various animals possesses decided germicidal power, and Buchner has shown that this property belongs to the fluid part of the blood and not to its cellular elements. This power to kill bacteria is destroyed by heat, and is lost when the blood has been kept for a considerable time, but it is not neutralized by freezing. Further, this power to destroy bacteria differs greatly for different species, being very decided in the case of certain pathogenic bacteria, less so for others, and absent in the case of certain common saprophytes.

In the infectious diseases of man involving the system generally, a single attack commonly confers immunity from subsequent attacks. This is true of the eruptive fevers, of typhoid fever, of yellow fever, of mumps, of whooping-cough, and, to some extent at least, of syphilis. But it seems not to be the case in epidemic influenza (*la grippe*), in croupous pneumonia, or in Asiatic cholera, in which diseases second attacks not infrequently occur. In localized infectious diseases, such as diphtheria, erysipelas, and gonorrhœa, one attack is not protective. Croupous pneumonia and Asiatic cholera should perhaps be grouped with diphtheria and erysipelas as local infections with constitutional symptoms resulting from the absorption of toxic products.

That immunity may result from a comparatively mild attack as well as from a severe one is a matter of common observation in the case of small-pox, scarlet fever, yellow fever, etc., and since the discovery of Jenner we have in vaccination a simple method of producing immunity in the first-mentioned disease. The acquired immunity resulting from vaccination is not, however, as complete or as permanent as that which results from an attack of the disease.

These general facts relating to acquired immunity from infectious diseases constituted the principal portion of our knowledge with reference to this important matter up to the time that Pasteur (1880) demonstrated that in the disease of fowls known as chicken cholera, which he had proved to be due to a specific micro-organism, a mild attack followed by immunity may be induced by inoculation with an "attenuated virus"—i. e., by inoculation with a culture of the pathogenic micro-organism the virulence of which had been so modified that it gave rise to a comparatively mild attack of the disease in question. Pasteur's original method of obtaining an attenuated virus consisted in exposing his cultures for a considerable time to the action of atmospheric oxygen. It has since been ascertained that the same result is obtained with greater certainty by exposing cultures for a given time to a temperature slightly below that which would

destroy the vitality of the pathogenic micro-organism, and also by exposure to the action of certain chemical agents.

Pasteur at once comprehended the importance of his discovery, and inferred that what was true of one infectious germ disease was likely to be true of others. Subsequent researches by this *savant* and by other bacteriologists have justified this anticipation, and the demonstration has already been made for a considerable number of similar diseases—anthrax, symptomatic anthrax, rouget, etc.

In Pasteur's inoculations against anthrax, "attenuated" cultures are employed which contain the living pathogenic germ as well as the toxic products developed during its growth. Usually two inoculations are made with cultures of different degrees of attenuation—that is to say, with cultures in which the toxic products are formed in less amount than in virus of full power.

The most attenuated virus is first injected, and after some time the second vaccine, which if injected first might have caused a considerable mortality. The animal is thus protected from the pathogenic action of the most virulent cultures.

Now, it has been shown by recent experiments that a similar immunity may result from the injection into a susceptible animal of the toxic products contained in a virulent culture, independently of the living bacteria to which they owe their origin. The first satisfactory experimental evidence of this important fact was obtained by Salmon and Smith in 1886, who succeeded in making pigeons immune from the pathogenic effects of cultures of the bacillus of hog cholera by inoculating them with sterilized cultures of this bacillus. In 1888 Roux reported similar results obtained by injecting into susceptible animals sterilized cultures of the anthrax bacillus. Behring and Kitasato have quite recently reported their success in establishing immunity against virulent cultures of the bacillus of tetanus and the diphtheria bacillus by inoculating susceptible animals with filtered, germ-free cultures of these pathogenic bacteria.

In Pasteur's inoculations against hydrophobia, made subsequently to infection by the bite of a rabid animal, an attenuated virus is introduced subcutaneously in considerable quantity by daily injections, and immunity is established during the interval, the so-called period of incubation, which usually occurs between the date of infection and the development of the disease. That the immunity in this case also depends upon the introduction of a chemical substance present in the desiccated spinal cord of rabbits which have succumbed to rabies, which is used in these inoculations, is extremely probable. But, as the germ of rabies has not been isolated or cultivated artificially, this has not yet been demonstrated.

With these facts in view, let us proceed to consider briefly the various theories which have been offered in explanation of acquired immunity:

EXHAUSTION THEORY.—For a time Pasteur supported the view that during an attack of an infectious disease the pathogenic micro-organism, in its multiplication in the body of a susceptible animal, exhausts the supply of some substance necessary for its development, that this substance is not subsequently reproduced, and that consequently the same pathogenic germ can not again multiply in the body of the protected animal.

In discussing this theory, in a paper published in the American Journal of the Medical Sciences (April, 1881), the writer says:

> Let us see where this hypothesis leads us. In the first place, we must have a material of small-pox, and a material of measles, and a material of scarlet fever, etc. Then we must admit that each of these different materials has been formed in the system and stored up for these emergencies—attacks of the diseases in question—for we can scarcely conceive that they were all packed away in the germ-cell of the mother and the sperm-cell of the father of each susceptible individual. If, then, these peculiar materials have been formed and stored up during the development of the individual, how are we to account for the fact that no new production takes place after an attack of any one of the diseases in question?
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> Again, how shall we account for the fact that the amount of material which would nourish the small-pox germ, to the extent of producing a case of confluent small-pox, may be exhausted by the action of the attenuated virus (germ) introduced by vaccination? Pasteur's comparison of a fowl protected by inoculation with the microbe of fowl cholera, with a culture fluid in which the growth of a particular organism has exhausted the pabulum necessary for the development of additional organisms of the same kind, does not seem to me to be a just one, as in the latter case we have a limited supply of nutriment, while in the former we have new supplies constantly provided of the material—food—from which the whole body, including the hypothetical substance essential to the development of the disease-germ, was built up prior to the attack. Besides this, we have a constant provision for the elimination of effete and useless products.
>
> This hypothesis, then, requires the formation in the human body, and the retention up to a certain time, of a variety of materials which, so far as we can see, serve no purpose except to nourish the germs of various specific diseases, and which, having served this purpose, are not again formed in the same system, subjected to similar external conditions, and supplied with the same kind of nutriment.

It is unnecessary to discuss this hypothesis any further, inasmuch as it is no longer sustained by Pasteur or his pupils, and is evidently untenable.

THE RETENTION THEORY, proposed by Chauveau (1880), is subject to similar objections. According to this view, certain products formed during the development of a pathogenic micro-or-

ganism in the body of a susceptible animal accumulate during the attack and are subsequently retained, and being prejudicial to the growth of the particular micro-organism which produced them, a second infection can not occur. Support for this theory has been found by its advocates in the fact that various processes of fermentation are arrested after a time by the formation of substances which restrain the development of the micro-organisms to which they are due. But in the case of a living animal the conditions are very different, and it is hard to conceive that adventitious products of this kind could be retained for years, when in the normal processes of nutrition and excretion the tissues and fluids of the body are constantly undergoing change. Certainly the substances which arrest ordinary processes of fermentation by their accumulation in the fermenting liquid, such as alcohol, lactic acid, phenol, etc., would not be so retained. But we can not speak so positively with reference to the toxic albuminous substances which recent researches have demonstrated to be present in cultures of some of the best-known pathogenic bacteria. It is difficult, however, to believe that an individual who has passed through attacks of half a dozen different infectious diseases, carries about with him a store of as many different chemical substances produced during these attacks, and sufficient in quantity to prevent the development of the several germs of these diseases. Nor does the experimental evidence relating to the action of germicidal and germ-restraining agents justify the view that a substance capable of preventing the development of one micro-organism should be without effect upon others of the same class; but if we accept the retention hypothesis, we must admit that the inhibiting substance produced by each particular pathogenic germ is effective only in restraining the development of the microbe which produced it in the first instance.

Moreover, if we suppose that the toxic substances which give pathogenic power to a particular micro-organism are retained in the body of an immune animal, we must admit that the animal has acquired a tolerance to the pathogenic action of these toxic substances, for their presence no longer gives rise to any morbid phenomena. And this being the case, we are not restricted to the explanation that immunity depends upon a restraining influence exercised upon the microbe when subsequently introduced.

Another explanation offers itself, viz., that *immunity depends upon an acquired tolerance to the toxic products of pathogenic bacteria.* This is a view which the writer has advocated in various published papers since 1881. In a paper contributed to the American Journal of the Medical Sciences in April, 1881, it is presented in the following language: "The view that I am endeavor-

ing to elucidate is that, during a non-fatal attack of one of the specific diseases, the cellular elements implicated which do not succumb to the destructive influence of the poison acquire a tolerance to this poison which is transmissible to their progeny, and which is the reason of the exemption which the individual enjoys from future attacks of the same disease."

In my chapter on Bacteria in Infectious Diseases, in Bacteria, published in the spring of 1884, but placed in the hands of the publishers in 1883, I say: "It may be that the true explanation of the immunity afforded by a mild attack of an infectious germ disease is to be found in an acquired tolerance to the action of a chemical poison produced by the micro-organism, and consequent ability to bring the resources of Nature to bear to restrict invasion by the parasite." This theory of immunity has received considerable support from investigations made since that date, and especially from the experimental demonstration by Salmon, Roux, and others that, as suggested in the work from which I have quoted, immunity may result from the introduction into the body of a susceptible animal of the soluble products of bacterial growth—filtered cultures.

The theory of vital resistance to the toxic products evolved by pathogenic bacteria is also supported by numerous experiments which show that natural or acquired immunity may be overcome when these toxic products are introduced in excess, or when the vital resisting power of the animal has been reduced by various agencies. Thus Roger has shown that the rabbit, which has a natural immunity against symptomatic anthrax, succumbs to infection when inoculated with a culture of the bacillus of this disease, if at the same time it receives an injection of a sterilized or non-sterilized culture of *Bacillus prodigiosus*. Monti has succeeded in killing animals with old and attenuated cultures of the *Streptococcus pyogenes* or of *Staphylococcus pyogenes aureus*, by injecting at the same time a culture of *Proteus vulgaris*. A similar result may be obtained by subjecting animals to physical agencies which reduce the vital resisting power of the tissues. Thus, Nocard and Roux found by experiment that an attenuated culture of the anthrax bacillus, which was not fatal to guinea-pigs, killed these animals when injected into the muscles of the thigh after they had been bruised by mechanical violence. Charrin and Roger found that white rats, which are insusceptible to anthrax, became infected and frequently died if they were exhausted, previous to inoculation, by being compelled to turn a revolving wheel for a considerable time. Pasteur found by experiment that fowls, which have a natural immunity against anthrax, become infected and perish if they are subjected to artificial refrigeration after inoculation. This has been confirmed by the

more recent experiments of Wagner (1890). According to Canalis and Morpurgo, pigeons which are enfeebled by inanition easily contract anthrax as a result of inoculation. Arloing states that sheep which have been freely bled contract anthrax more easily than others; and Serafini found that when dogs were freely bled, the bacillus of Friedländer, injected into the trachea or the pleural cavity, entered and apparently multiplied to some extent in the blood, whereas without such previous bleeding they were not to be found in the circulating fluid. Again, the simultaneous injection of certain chemical substances may overcome the vital resisting power of the tissues or fluids of the body in such a way that infection and death may occur as a result of inoculations into animals which have a natural or acquired immunity against the pathogenic micro-organisms introduced. Thus Arloing, Cornevin, and Thomas have shown that rabbits succumb to symptomatic anthrax when lactic acid is injected at the same time with the bacillus into the muscles. Nocard and Roux have obtained the same result by injecting various other substances, and their experiments show that the result is due to the injurious effects of the substance injected upon the tissues, and not to an increased virulence on the part of the pathogenic bacillus. The experiments of Leo are of a similar nature. By injecting phloridzin into rats he caused them to lose their natural immunity against anthrax. Certain anæsthetic agents have also been shown to produce a similar result. Platania communicated anthrax to immune animals—dogs, frogs, pigeons—by bringing them under the influence of curare, chloral, or alcohol; and Wagner obtained a similar result in his experiments on pigeons to which he had administered chloral.

In view of the results of recent experimental researches which show that, in certain cases at least, acquired immunity depends upon the formation of an antitoxine in the body of the immune animal, we are convinced that the theory of immunity under discussion, first proposed by the writer in 1881, can not be accepted as a sufficient explanation of the facts in general. At the same time we are inclined to attribute considerable importance to acquired tolerance to the toxic products of pathogenic bacteria as one of the factors by which recovery from an infectious disease is made possible, and subsequent immunity established. Of course, when we ascribe immunity to the "vital resistance" of the cellular elements of the body, we have not explained the *modus operandi* of this vital resistance or "reactive change," but have simply affirmed that the phenomenon in question depends upon some acquired property residing in the living cellular elements of the body. We have suggested that that which has been acquired is a tolerance to the action of the toxic products produced by pathoge-

nic bacteria. But, as already stated, in the light of recent experiments, this theory now appears to us to be untenable as a general explanation of acquired immunity.

THE THEORY OF PHAGOCYTOSIS.—The fact that in certain infectious diseases due to bacteria the parasitic invaders, at the point of inoculation or in the general blood-current, are picked up by the leucocytes, and in properly stained preparations may be seen in their interior, has been known for some years. Now, the theory of phagocytosis assumes that the bacilli are picked up by the leucocytes and destroyed in their interior, and that immunity depends largely upon the power of these "phagocytes" to capture and destroy living pathogenic bacilli.

The writer suggested this as a hypothesis as long ago as 1881, in a paper read August 18, 1881, before the American Association for the Advancement of Science, in the following language: "It has occurred to me that possibly the white corpuscles may have the office of picking up and digesting bacterial organisms which by any means find their way into the blood. The propensity exhibited by the leucocytes for picking up inorganic granules is well known, and that they may be able not only to pick up but to assimilate, and so dispose of, the bacteria which come in their way, does not seem to me very improbable, in view of the fact that amœbæ, which resemble them so closely, feed upon bacteria and similar organisms."

At a later date (1884) Metschnikoff offered experimental evidence in favor of this view, and the explanation suggested in the above quotation is commonly spoken of as the *Metschnikoff theory*. The observations which first led Metschnikoff to adopt this view were made upon a species of daphnia which is subject to fatal infection by a torula resembling the yeast fungus. Entering with the food, this fungus penetrates the walls of the intestine and invades the tissues. In certain cases the infection does not prove fatal, owing, as Metschnikoff asserts, to the fact that the fungus cells are seized upon by the leucocytes, which appear to accumulate around the invading parasite (*chemiotaxis*) for this special purpose. If they are successful in overpowering and destroying the parasite, the animal recovers; if not, it succumbs to the general infection which results. In a similar manner, Metschnikoff supposes, pathogenic bacteria are destroyed when introduced into the body of an immune animal. The colorless blood-corpuscles, which he designates *phagocytes*, accumulate at the point of invasion and pick up the living bacteria, as they are known to pick up inorganic particles injected into the circulation. So far there can be no doubt that Metschnikoff is right. The presence of bacteria in the leucocytes in considerable numbers, both at the point of inoculation and in the general circulation, has been repeatedly

demonstrated in animals inoculated with various pathogenic bacteria. The writer observed this in his experiments, made in 1881, in which rabbits were inoculated with cultures of his *Micrococcus Pasteuri;* and it was this observation which led him to suggest the theory which has since been so vigorously supported by Metschnikoff. But the presence of a certain number of bacteria within the leucocytes does not prove the destructive power of these cells for living pathogenic organisms. As urged by Weigert, Baumgarten, and others, it may be that the bacteria were already dead when they were picked up, having been destroyed by some agency outside of the blood-cells. As heretofore stated, we have now experimental evidence that blood-serum, quite independently of the cellular elements contained in it in the circulation, has decided germicidal power for certain pathogenic bacteria, and that the blood-serum of the rat and other animals which have a natural immunity against anthrax is especially fatal to the anthrax bacillus.

Numerous experiments have been made during the past two or three years with a view to determining whether pathogenic bacteria are, in fact, destroyed within the leucocytes after being picked up, and different experimenters have arrived at different conclusions. But in certain infectious diseases, and especially in anthrax, the bacilli included within the leucocytes often give evidence of degenerative changes, which would support the view that they are destroyed by the leucocytes, unless these changes occurred before they were picked up, as is maintained by Nuttall and others.

Metschnikoff concludes an address delivered at the Pasteur Institute in Paris, in December, 1890, as follows: "It is not possible at the present time to state fully and accurately all these influences which are associated in aiding phagocytic action; but already we have the right to maintain that, *in the property of its amœboid cells to include and to destroy micro-organisms, the animal body possesses a formidable means of resistance and defense against these infectious agents.*" This statement, we think, is justified by the experimental evidence relating to phagocytosis. But in view of experimental evidence, to be referred to later we can not accept the so-called Metschnikoff theory as a sufficient explanation for the facts relating to acquired immunity in general, and must regard phagocytosis simply as a factor which, in certain infectious diseases, appears to play an important part in enabling immune animals to resist invasion by pathogenic bacteria.

Going back to the demonstrated fact that susceptible animals may be made immune by inoculating them with the toxic products produced during the growth of certain pathogenic bacteria, we may suppose either that immunity results from the continued

presence of these toxic products in the body of the inoculated animal, or to a tolerance acquired at the time of the inoculation and subsequently retained, by transmission from cell to cell, as heretofore suggested. Under the first hypothesis—retention theory—immunity may be explained as due to a continued tolerance on the part of the cellular elements of the body to the toxic substances introduced and retained, or to the effect of these retained toxic products in destroying the pathogenic bacteria, or in neutralizing their products when these are subsequently introduced into the body of the immune animal. We can not understand how toxic substances introduced in the first instance can neutralize substances of the same kind introduced at a later date. There is something in the blood of the rat which, according to Behring, neutralizes the toxic substances present in a filtered culture of the tetanus bacillus; but whatever this substance may be, it is evidently different from the toxic substance which it destroys, and there is nothing in chemistry to justify the supposition last made. Is it, then, by destroying the pathogenic micro-organism, that these inoculated and retained toxic products preserve the animal from future infection? Opposed to this supposition is the fact that the blood of an animal made immune in this way, when removed from the body does not prove to have increased germicidal power as compared with that of a susceptible animal of the same species. Again, these same toxic substances in cultures of the anthrax bacillus, the tetanus bacillus, the diphtheria bacillus, etc., do not destroy the pathogenic germ after weeks or months of exposure. And, when we inoculate a susceptible animal with a virulent culture of one of these micro-organisms, the toxic substances present do not prevent the rapid development of the bacillus; indeed, instead of proving a germicide they favor its development, which is more abundant and rapid than when attenuated cultures containing less of the toxic material are used for the inoculation. In view of these facts it is evident that acquired immunity does not result from the direct action of the products of bacterial growth, introduced and retained in the body of the immune animal, upon the pathogenic micro-organism when subsequently introduced, or upon its toxic products.

But there is another explanation which, although it may appear *a priori* to be quite improbable, has the support of recent experimental evidence. This is the supposition that *some substance is formed in the body of the immune animal which neutralizes the toxic products of the pathogenic micro-organism.* How the presence of these toxic products in the first instance brings about the formation of an "antitoxine" by which they are neutralized is still a mystery; but that such a substance is formed appears to be proved by the recent experiments of Ogata, Behring and Kita-

sato, Tizzoni and Cattani, G. and F. Klemperer, and others, including my own.

Ogata and Jasuhara, in a series of experiments made in the Hygienic Institute at Tokio (1890), discovered the important fact that the blood of an animal immune against anthrax contains some substance which neutralizes the toxic products of the anthrax bacillus. When cultures were made in the blood of dogs, frogs, or of white rats, which animals have a natural immunity against anthrax, they were found not to kill mice inoculated with them. Further experiments showed that mice inoculated with virulent anthrax cultures did not succumb to anthrax septicæmia if they received at the same time a subcutaneous injection of a small quantity of the blood of an immune animal. So small a dose as one drop of frog's blood, or one half drop of dog's blood, proved to be sufficient to protect a mouse from the fatal effect of an anthrax inoculation. And the protective inoculation was effective when made as long as seventy-two hours before, or five hours after, infection with an anthrax culture. Further, it was found that mice which had survived anthrax infection as a result of this treatment were immune at a later date (after several weeks) when inoculated with a virulent culture of the anthrax bacillus. Behring and Kitasato have obtained similar results in their experiments upon tetanus and diphtheria, and have shown that the blood of an immune animal, added to virulent cultures before inoculation into susceptible animals, neutralizes the pathogenic power of these cultures. Tizzoni and Cattani ascribe the protection of animals which have acquired an immunity against tetanus to the presence of an albuminous substance which they call the tetanus antitoxine. This they have isolated from the blood of immune animals; and have shown by experiment that it neutralizes the potent toxalbumin of tetanus in test-tube cultures as well as in the bodies of infected animals. G. and F. Klemperer have recently (1891) published an important memoir in which they give an account of their researches relating to the question of immunity, etc., in animals subject to the form of septicæmia produced by the *Micrococcus pneumoniæ crouposæ*. They were able to produce immunity in susceptible animals by introducing into their bodies filtered cultures of this micrococcus, and proved by experiment that this immunity had a duration of at least six months. They arrive at the conclusion that the immunity induced by injecting filtered cultures is not directly due to the toxic substances present in these cultures, but that they cause the production in the tissues of an antitoxine which has the power of neutralizing their pathogenic action. Emmerich, in a communication made at the recent (1891) International Congress for Hygiene and Demography, in London, reports results which cor-

respond with those of G. and F. Klemperer so far as the production of immunity is concerned, and also gives an account of experiments made by Dönissen in which the injection of twenty to twenty-five cubic centimetres of blood or expressed tissue juices, filtered through porcelain, from an immune rabbit into an unprotected rabbit, subsequently to infection with a bouillon culture of "*Diplococcus pneumoniæ*," prevented the development of fatal septicæmia. Even when the injection was made twelve to fifteen hours after infection, by inhalation, the animal recovered. Emmerich and Mastraum had previously reported similar results in experiments made upon mice with the *Bacillus erysipelatos suis* (rothlauf bacillus). White mice are very susceptible to the pathogenic action of this bacillus. But mice which, subsequently to infection, received by injection the expressed and filtered tissue juices of an immune rabbit, recovered, while the control animals succumbed. According to Emmerich, the result in these experiments was due to a destruction of the pathogenic bacilli in the bodies of the injected animals; and the statement is made that at the end of eight hours after the injection of the expressed tissue juices all bacilli in the body of the infected animal were dead. The same liquid did not, however, kill the bacilli when added to cultures external to the body of an animal. The inference, therefore, seems justified that the result depends, not upon a substance present in the expressed juices of an immune animal, but upon a substance formed in the body of the animal into which these juices are injected. We have, however, an example of induced immunity in which the result appears to depend directly upon the destruction of the pathogenic micro-organism in the body of the immune animal. In guinea-pigs, which have an acquired immunity against *Vibrio Metschnikovi*, the blood-serum has been proved to possess decided germicidal power for this "vibrio," whereas it multiplies readily in the blood-serum of non-immune guinea-pigs. (Behring and Nissen.)

The antitoxines thus far referred to are from animals which have an acquired immunity against virulent cultures of well-known pathogenic bacteria. But we have also experimental evidence showing the presence of antitoxines in animals immune against rabies and against vaccinia, two infectious diseases in which the specific infectious agent has not been demonstrated. Prof. Tizzoni, and his associate, Dr. Schwarz, have recently (1892) published the results of their experiments relating to the presence of an antitoxine in the blood of rabbits which have an acquired immunity against rabies. And I have shown by experiments made during the past two months that the blood of vaccinated and consequently immune calves contains an antitoxine which neutralizes the specific virulence of vaccine virus, both

human and bovine; also that blood-serum from a person who has recently suffered an attack of small-pox neutralizes vaccine virus after contact for two or three hours.

The account which I have given of the experimental evidence relating to the presence of antitoxines, or, as they are called by Hankin, "defensive proteids," in the body of immune animals has been largely taken from a paper which I read at the recent meeting (May, 1892) of the Association of American Physicians, entitled Practical Results of Bacteriological Researches. Time will not permit me on the present occasion to consider the question of therapeutic possibilities in the use of antitoxines, but I may mention that already we have reports of six cases of traumatic tetanus successfully treated with the tetanus antitoxine obtained by Prof. Tizzoni from the blood of immune dogs. I confess I have sanguine hopes that other infectious diseases may prove to be amenable to a similar specific treatment. But, whatever may be the practical results following the discovery of these "defensive proteids" in the bodies of immune animals, it must be admitted that this addition to our knowledge is an important event in the history of scientific medicine. For this reason, and because the experimental evidence is of such recent date that the facts are not generally known, I have made this the principal topic of my address. It is scarcely necessary to add that the experimental evidence detailed gives strong support to the view that acquired immunity depends upon the formation of antitoxines in the bodies of immune animals. It is also probable that recovery from an infectious disease depends upon the formation of an antitoxine during the attack, by which the toxic substances giving rise to the morbid phenomena characterizing each specific disease are neutralized in the body of the infected individual.

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A RECENT notice in the Monthly of a book on Right-handedness has called forth from Mr. George Wilson, President of the Lafayette County Bank, Lexington, Mo., the story of the "office cat of the bank, Ephraim, who is decidedly and persistently right-handed." "He sometimes," says Mr. Wilson, "laps milk like other cats, and sometimes sits close up to the pan and dips his paw in the milk and carrying it to his mouth, licks the drop of milk off. Noticing that he always used his right paw, I tried to get him to use the left one, first by setting the pan of milk on his left side and afterward by dipping his left foot in the milk, so as to get him started in the use of the left. He would shake the milk off his left paw and go on eating with the right one, and we have never by any expedient been able to get him to eat with the left paw."

A POLYNESIAN SOCIETY has been formed in Wellington, New Zealand, the chief object of which is to secure as far as possible a systematic study of the ethnology and philology of the island groups collectively designated as Polynesia.

# FURTHER STUDY OF INVOLUNTARY MOVEMENTS.*

By JOSEPH JASTROW, Ph. D.,

PROFESSOR OF EXPERIMENTAL AND COMPARATIVE PSYCHOLOGY IN THE UNIVERSITY OF WISCONSIN.

IN a former article (Popular Science Monthly, April, 1892) various illustrations were given of the involuntary movements of the hand toward the object or locality to which the subject was giving his attention: whether he were counting the strokes of a metronome or the oscillations of a pendulum, reading colors or words, thinking of a building, locality, or hidden object, a very fair though variable index of the direction of his thoughts could be derived from the involuntary movements of the hand. The record was obtained by means of an apparatus called the automatograph, the essential parts of which were a pair of glass plates, suitably mounted, and between them three well-turned brass balls; the hand rests upon the upper plate, which, upon the slightest impulse, rolls upon the balls, and the movement thus imparted to the plate is recorded. The recording device may be used separately, and is shown in full size in Fig. 1. There is a cork C, pierced by a glass tube T, within which a pointed glass rod R moves freely up and down; a rubber band B is useful in raising the pencil from the record as well as in preventing the rod from falling through the tube. The record is made upon a piece of glazed paper stretched over the glass of a ground-glass drawing-frame, such as children use for tracing outlines; the paper is blackened with lamp-soot, and the record may be made permanent by bathing it in shellac and alcohol. This recording device, without anything else, will record involuntary movements: the cork is held in the extended hand with the rod over the record-plate, which is placed upon a table; or, again, the record-plate may be held in the hand and the recording device held firmly over

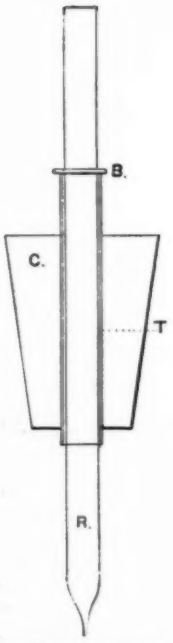


FIG. 1.—DEVICE FOR RECORDING MOVEMENTS. The glass rod, R, moves freely up and down in the glass tube, T, held in the cork, C. The rubber band, B, prevents the rod from falling through the tube.

* The results of this paper were obtained with the co-operation of Thomas P. Carter and Edward P. Sherry, of the class of 1892, University of Wisconsin.

it.* In either way we have an extremely simple means of obtaining records of involuntary movements, which any one interested

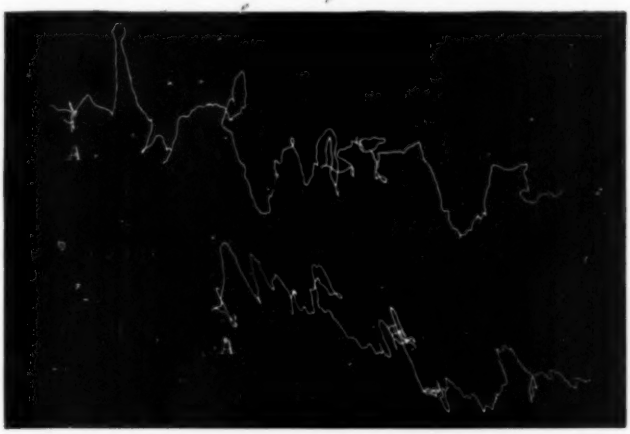

FIG. 2.—COUNTING METRONOME. ■→ Upper line, movements of head; lower line, of hand on automatograph; time, 45 seconds. The head movements are reversed, but have been again reversed for readier comparison. Figs. 2 to 11 are all obtained upon the same subject. The arrows indicate the direction in which the object attended to was situated.

may construct and test for himself. The use of such a device is not confined to the hand; the plate or the rod may be fixed to other portions of the body.

Having shown that the hand moves toward the direction of one's thoughts, the next important step is to determine whether this movement is altogether the expression of the subject's mental activity, and, if not, what other factors

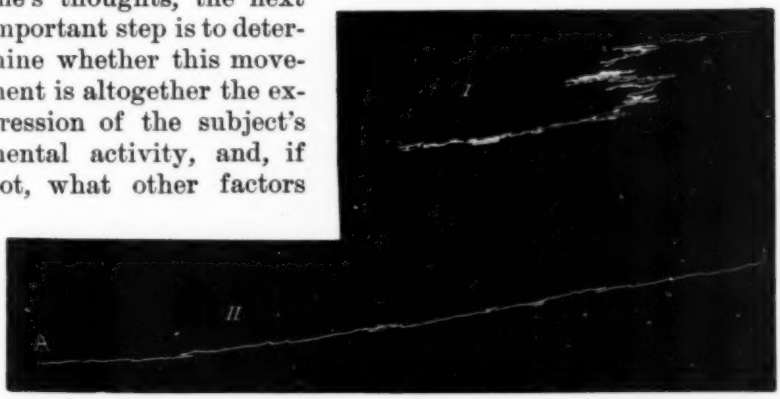

FIG. 3.—COUNTING METRONOME. Facing ■→. Automatograph, sitting. I, ←■; time, 105 seconds. II, ■→; time, 45 seconds.

contribute to it; and, further, in what part or parts of the body it originates, what are its components, and the like. These movements have a close connection with the body as well as with the

* It is to be noted that in this case the record will be in a direction the opposite of the real movement.

mind, and it is essential to determine in what measure each appears in the general result.

If you hold out your arm nearly on a level with the shoulders and in line with them, you perceive at once that movements of the hand to the front are much more readily made than to the rear, and movements toward the body more readily than those away from the body; the tendency of the hand is to move along a circle of which the shoulder is the center. What we require is a position in which movements in any direction are as readily made as in any other; and this may be approximated, though only approximated, by holding the hand at an angle of about 45° with the line joining the shoulders, and with the elbow bent at an angle of about 120°; this position * is

FIG. 4.— ⇻ COUNTING METRONOME. Right hand holds pencil, left hand holds record; time of each, 90 seconds. Facing ⇻. Upper line, standing; lower line, sitting.

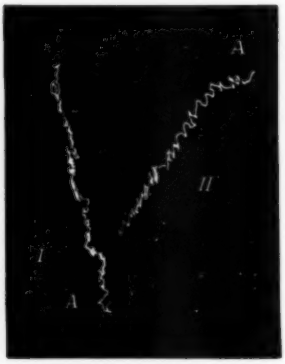

FIG. 5.—THINKING OF A BUILDING. Facing ↕; standing. Right hand holds pencil, left hand holds record; time of each, 60 seconds. I, ↑; II, ↕; shows respiration.

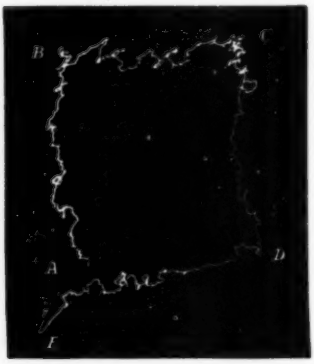

FIG. 6.—COUNTING METRONOME. Right hand holds pencil, left hand holds record. From A to B, ↑; from B to C, ⇻; from C to D, ↕; from D to E, ⇺; standing; each part, 45 seconds.

recommended for the normal tests. The usual result is a movement toward the object of attention; but when that is to the rear, this tendency is sometimes outweighed by the natural tendency

* In one series we were able to measure the extent of movements in various directions, and found half again as much movement toward the front as toward the rear, and a third again as much toward as away from the body.

for the arm to move forward, and the result is then a smaller and less direct movement forward than when the object of attention is to the front. An instance of this, obtained under other but comparable circumstances, appears in Fig. 3, while Figs. 5 and 6 illustrate the more usual result. We conclude, then, that the position of the body is an important factor, but does not detract from the accepted psychological interpretation of these movements. While observing the subject we may note movements of the body as a whole, and of the arm or hand; the movement of the body is an irregular swaying with the feet as the point of attachment, and this we recorded by fixing the recording plate upon the subject's head, and suspending the pencil above it. It was found that the head like the hand moved toward the object of at-

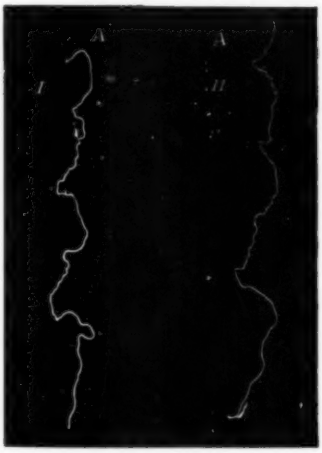

FIG. 7.—↑ THINKING OF A BUILDING. Standing ↕. I, left hand; II, right hand; both holding record near the body; time, 35 seconds; records reversed.

FIG. 8.—↑ THINKING OF A BUILDING. Facing ↕. I, left hand held extended far out; II, right hand held close to body; each hand holds record; time, 35 seconds; records reversed.

tention; and, further, that it moved as readily toward the object when the latter was to the front, to the rear, or to either side. To determine how far this swaying is the same in head and hand, we record both at the same time. Fig. 2 illustrates the correspondence of the two movements. From a number of such tests we conclude that the swaying of the body contributes an important factor to the automatograph records, and that the movements of the head are apt to be more extensive than those of the hand.

To eliminate this swaying of the body, we may experiment with the subject seated; we then obtain a distinctive record II (of Fig. 3), in which the oscillations have almost disappeared, and in which the tendency to move along a circle is marked. A still better method of eliminating this swaying is to hold the recording plate

in one hand and the pencil in the other; in this way the pencil and the plate sway alike, and no record of it is made. The very fine movements thus obtained are shown in Fig. 4; this figure also shows the slight difference between a record taken by this method while the subject is sitting and while standing, which further proves that the swaying of the body has been eliminated. Traces of periodic oscillations are noted in Fig. 4; these are due to respiration movements, and in II, of Fig. 5, they are unusually distinct and regular, about twenty to the minute. The forearm of the hand holding the record-plate rests against the body while the recording hand is held free from it, and thus the abdominal movements are recorded. The movements toward the object of attention appear

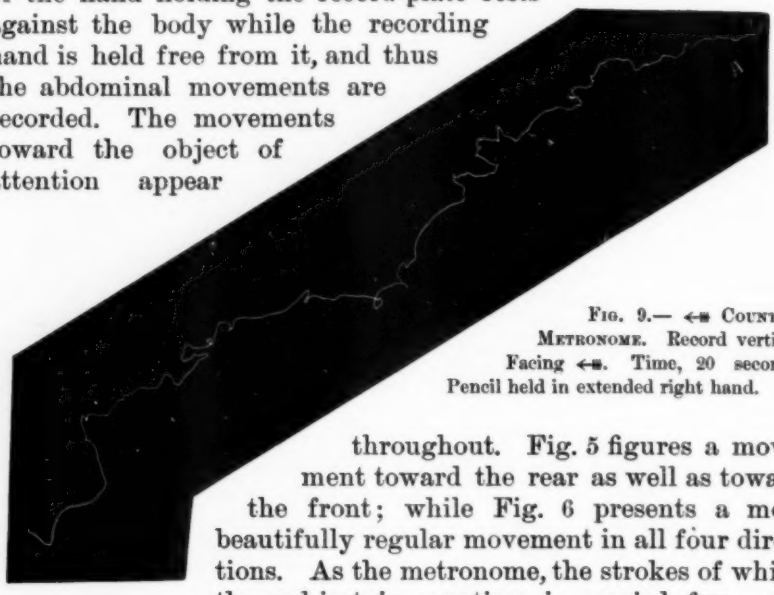

FIG. 9.— ←■ COUNTING METRONOME. Record vertical. Facing ←■. Time, 20 seconds. Pencil held in extended right hand.

throughout. Fig. 5 figures a movement toward the rear as well as toward the front; while Fig. 6 presents a most beautifully regular movement in all four directions. As the metronome, the strokes of which the subject is counting, is carried from one corner of the room to the next, the hand involuntarily follows it and records an almost perfect square.

It is further interesting to record the movements of the two hands during the same experiment; a correspondence of movement would be attributed to a common swaying of the body, but this would not exclude symmetrical movements of the hands as well. Fig. 7 illustrates the close similarity of the movements; while Fig. 8 shows the importance of the position of the arms in such an experiment. The hand that is held away from the body moves more extensively; the form of the movement remains similar. All the above records (and Figs. 9, 10, and 14) were obtained upon the same subject; they are therefore comparable with one another, and illustrate the analysis of the resulting movements into their several factors.

Involuntary movements are not limited to the horizontal plane; we may record vertical movements by holding the record-

ing device in a slanting position, and fixing the record-plate upon the wall. The main characteristic of such a record is the sinking of the arm from fatigue; the movement is rapid and coarse (I of Fig. 10). If the attention be directed to the front, we obtain a resultant of the two tendencies, as is shown in the diagonal line of Fig. 9. Fig. 10 illustrates an interesting point similar to that illustrated in Fig. 3. When the attention is directed downward, the hand falls rapidly, I; but when the attention is directed upward, very little movement at all takes place —the tendency to move toward the object of attention constantly counteracting the tendency for the arm to fall.

FIG. 10.—I, ↓ RECORD-PLATE VERTICAL. Thinking of one's feet. Time, 45 seconds. II, ↕ thinking of a point overhead. Time, 45 seconds.

While we have not been altogether successful in recording by these involuntary movements the various powers of different sense-impressions to hold the attention, the few successful results are especially interesting. In Fig. 11 the outline I is the movement of the hand during the thirty-five seconds that the subject was counting the strokes of a metronome; the outline II is the movement while counting for twenty-five seconds the oscillations of a pendulum. The latter movement is much more extensive than the former; the visual holds the attention better than the auditory impression. The subject of this record is a noted American novelist, and his description of his own mental processes entirely corresponds with this result. He is a good visualizer, and is eye-minded in every respect.

We turn to Fig. 12. The subject was asked to call the names of a series of small patches of colored papers hanging upon the wall in front of him. He did this with some uncertainty for

thirty-five seconds, and during this time his hand on the automatograph moved from A to A′. At the latter point he was asked to count the oscillations of a pendulum; this entirely changed the movement, the hand at once moving rapidly toward the pendulum. The pendulum was a more attractive sense-impression than the colors; the special point of interest in this record is, that upon

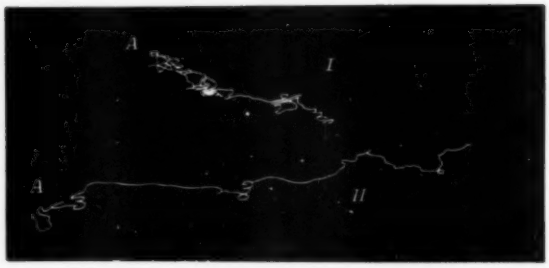


FIG. 11.— ■→ I, COUNTING METRONOME. Automatograph. Facing ■→. Time, 35 seconds. ■→ II, COUNTING PENDULUM. Automatograph. Facing ■→. Time, 25 seconds.

examination the subject's color-vision proved to be defective and thus explained the failure of the colors to hold his attention.

An important problem relates to the possible correlation of types of involuntary movements with age, sex, temperament, disease and the like. A few observations upon children are interesting in this regard. They reveal the limited control that children have over their muscles, and how difficult it is for them to fix the attention when and where desired. The movements they make are large, with great fluctuations, and irregularly toward the object of attention. Fig. 13 illustrates some of these points; in thirty-five seconds the child's hand moved by large steps seven

FIG. 12.— ■→ FACING ■→. HAND ON AUTOMATOGRAPH. From A to A′, reading colors, 35 seconds. From A′ on, counting pendulum, 25 seconds.

inches toward the pendulum, and the entire appearance of the outline is different from those obtained upon adults.

Much attention has recently been paid to automatic writing, or the unconscious indication of the nature, not the direction, of one's thoughts while the attention is elsewhere engaged. We attempted this upon the automatograph by asking the subject to view or think of some letter or geometric figure, and then search-

ing the record for some trace of the outline of the letter or figure; but always with a negative result. While unsuccessful in this

FIG. 13.— ⇻ HAND ON AUTOMATOGRAPH. Facing ⇻. Counting pendulum. Time, 35 seconds. The record from B' to C is continuous with that of A to B. The subject a child of eleven years.

sense, the records prove of value in furnishing a valuable contrast to the experiments in which the attention was fixed in a definite direction. For example, the subject is thinking of the letter O; he does not think of it as in any special place, and the record, Fig. 14, likewise reveals no movement in any one direction. Two

FIG. 14.—THINKING OF LETTER O. Pencil in hand; record on table. I, standing; II, sitting.

records are shown quite similar in significance, and illustrating as well the difference between the movements while standing and while sitting.

We have thus illustrated a variety of involuntary movements obtained in different ways and with bearings upon many points of importance to the psychologist. They by no means exhaust the possibilities of research, or the deduction of conclusions in this field of study, but simply illustrate in an imperfect way how abundant and intricate are the expressions of the thoughts that lie within.

## THE WAGE-CONTRACT AND PERSONAL LIBERTY.*

By CONRAD RENO.

IN this reply to that part of Mr. Atkinson's interesting article which affirms that any State regulation of wages or of the hours of work is necessarily an abridgment of personal liberty, and therefore vicious and unjustifiable, the writer intends to confine his attention to two propositions: (1) That the settlement of labor disputes by the State does not necessarily involve an abridgment of personal liberty; (2) that compulsory arbitration through a State tribunal is the remedy for labor disputes, strikes, and lockouts.

The virtues of the "age of contract" are extolled by all disciples of the individualist school of thought, from Mr. Herbert Spencer to Mr. Edward Atkinson. Its superiority over the "age of status"—i. e., the age of slavery—no one will deny. Its adoption marks an upward step in the march of progress and civilization. As a means of attaining justice the contract has many advantages over the sword or brute force, by which human slavery was established and maintained. The right of contract is not, however, an end in itself (as this school seems to think), but merely a means to an end; and that end is justice. In the administration of justice experience has proved it to be necessary to impose many restrictions upon the right of free contract. Judge Ray has recently published a large legal work upon the subject of Contractual Limitations, and most persons will be surprised at the great number of restrictions that the law places upon this right. A full list of such cases would be tiresome, and only the more important ones will be mentioned. From time immemorial it has been customary for the State to fix a maximum rate of interest for the use of money, a maximum charge for the use of ferries, hacks, etc., for the services of millers in grinding corn, and a maximum charge of innkeepers and wharfingers for the use of their premises. In recent years the State has also fixed a maximum charge for the use of railroads and grain elevators. The constitutionality of State statutes fixing grain-elevator charges has been twice affirmed by the Supreme Court of the United States within twenty years, and the highest courts of the great States of New York and Illinois have also reached the same conclusion.† In the extensive class of insurance contracts the State

* A reply to Mr. Edward Atkinson's paper on Personal Liberty, in The Popular Science Monthly for February, 1892.

† Munn *vs.* Illinois, 94 U. S., 113; Budd *vs.* New York, 143 U S., 517; People *vs.* Budd, 117 N. Y., 1; Munn *vs.* People, 69 Ill., 80

does not hesitate to prescribe their terms and conditions and to prevent forfeitures by contract; and the constitutionality of such State statutes interfering with the freedom of contract has been upheld by the Supreme Court of the United States and by the highest State courts of Ohio and Wisconsin.* Besides these, there is a numerous class of contracts which the State declares shall not be made at all, or if made shall be void in law, because contrary to public policy, such as contracts in restraint of trade, gambling contracts, and contracts between husband and wife. Does Mr. Atkinson consider these State acts infringements of personal liberty or unjustifiable interferences with the freedom of contract? If so, he constitutes one of a small minority.

Turning now to the wage-contract, the question arises, "Is the State justified in fixing a minimum wage and a maximum time for work?" It is perhaps needless to say that the term "State" is here used to mean the people or the public acting through an agency or tribunal created by the people and in furtherance of their will. It does not mean something extrinsic and superior to the people's will, such as the monarchy of France was at the time when Louis XIV exclaimed, "I am the state!" In this country, if the State ever undertakes to regulate these matters, it will be done in pursuance of the will of the majority, and not of any one man or a minority. The businesses in which labor wishes the assistance of the State in the direction of restricting the freedom of contract are conducted almost exclusively by corporations under charters granted by the State. The three principal ones are railroading, manufacturing, and mining, and only an insignificant fraction of any one of these businesses is conducted by private individuals or partnerships. Although it may be of theoretic value, it is therefore of very little practical value to inquire into the right of the State to regulate the wage-contract between individuals. Now, the individual employer or partnership stands upon firmer ground in this respect than does the corporate employer. The State is justified in interfering with the latter more than with the former, for the reason that the corporation has received certain privileges and immunities from the State which the other employer has not received. In the first place, the corporation derives its being or existence from the State, and also its right to transact business. In the next place, the corporate form enables the capital of many individuals to be combined and used for one common purpose. But the most important immunity is that of limited liability, whereby the members of the corporation escape the uni-

* Equitable Life Insurance Company *vs.* Clements, 140 U. S., 226; Insurance Company *vs.* Leslie, 47 Ohio St., 409; Queen Insurance Company *vs.* Leslie, 24 N. E. Rep. (Ohio), 1072; Reilly *vs.* Franklin Insurance Company, 43 Wis., 449.

versal liability of individuals or partners, and only risk the portion of their wealth which they invest in the corporation. This feature of limited liability, probably more than any other, accounts for the growth and number of corporations. Private individuals or copartnerships do not enjoy this privilege or immunity, but remain liable to loss to the full extent of their possessions. It is clear, therefore, that the moral right of the State or society as a whole to regulate wage-contracts with a corporation is greater than with individuals or firms, provided the necessity exists and the wage-earners desire it. It is not intended to confine the discussion to the case of corporate employers, but merely to point out some differences between the two classes of employers.

Mr. Spencer's opinion that the State has no moral right to interfere with the freedom of contract between employer and employed, or to regulate wages in any way, is based upon the analogy supposed to exist between human labor and commodities. Because, in his opinion, the State has no right to regulate the price of bread, or the rate of interest, or the price of other commodities, therefore it has not the moral right to regulate the price of human labor, with the exception of labor for life, or slavery. Is this analogy correct? Is human labor a commodity? No; human labor is the creator of commodities, and commodities are things created by human labor. The creator is always superior to the thing created. The shoemaker is superior to the shoe; the watchmaker to the watch; and God to man. The slaveholder also believed that human labor when clothed in black was a commodity, and that negroes could be bought and sold as chattels; and it took four years of civil war to establish the contrary. Labor is much more than a commodity; it is the bone and sinew of the State, the very essence of its existence. It is the sole means of support of millions of human beings—men, women, and children. Those who have only their labor to sell are more entitled to the protection of the State than those who have commodities to sell.

Mr. Spencer's admission that the State has the right to forbid the sale of one's self into slavery, or the sale of one's services for life, as well as to hinder freedom of contract when it endangers national existence, also proves his analogy to be unsound. For, if the State may regulate or forbid the sale of one's services for life, it may also regulate the sale of one's services for ten years, or five years, or one year, or a shorter term; and, if the State may hinder the freedom of contract when national existence is thereby endangered, why may it not hinder the freedom of contract when the existence of a large body of its citizens is thereby endangered? Their existence is endangered when they can not, by

means of their utmost exertions, earn sufficient wages to purchase the necessaries of life.

That the great mass of wage-earners favor State regulation of some sort will probably be conceded. Scarcely a month passes that Congress and the State Legislatures are not asked by labor interests to restrict the freedom of contract in one way or another. They believe that their wages may be increased by legislation, just as the price of commodities is increased by tariff laws. If legislation can lower the rate of wages below the contract rate, it is difficult to see why it can not also raise the rate of wages above the contract rate. For centuries the employing class of England legislated in its own interest and kept the rate of wages below the contract rate. This they did, first, by various Statutes of Laborers, passed by Parliament, giving the employing class power to fix wages, and punishing laborers who asked or received higher wages; secondly, by laws abolishing trade guilds and confiscating their property; thirdly, by acts of Parliament and decisions of the courts holding that peaceful combinations among workmen to raise wages were conspiracies and punishable by fine or imprisonment; and, fourthly, by acts of Parliament debasing the currency, by which the purchasing power of the laborer's shilling or penny was greatly lessened. Prof. Rogers, in his great work entitled Six Centuries of Work and Wages, shows how by these various legislative means the English laborer's condition was reduced from that of comparative comfort in the fourteenth century to that of semi-starvation in the eighteenth. This system was inaugurated in 1350, shortly after the Great Plague, which destroyed one third of the entire population of England. At that time the employing class, which, of course, controlled legislation, seems to have had some excuse for passing the Statute of Laborers. The supply of labor being thus suddenly reduced one third, the demand was intense, and the laborers could get exorbitant prices for their work. The contract rate depending upon supply and demand was abnormally and unreasonably high,* and therefore the employing class brought all the machinery of the State to bear upon the situation, and finally succeeded in reducing the rate below the contract rate. This policy was pursued by England into the dawn of the nineteenth century, when, the conditions having changed and there being an oversupply of labor and the contract rate correspondingly low, the Statutes of Laborers were magnanimously repealed.

During all this time of State regulation of wages in favor of the employing class we look in vain for any philosopher to arise

* The preamble to the statute recites that wages had risen to double or treble the rate that prevailed immediately before the plague.

and proclaim that the sacred right of freedom of contract or of personal liberty was thereby impaired. But, as soon as there is a chance of the wage-earners being able to control legislation and they indicate their desire to increase wages, it is immediately discovered by many would-be teachers and philosophers of the individualist school that this sacred right is imperiled, and that it would be sacrilegious to touch it with the vulgar hand of the State. This school overlooks the actual condition of affairs and bases its conclusions on an ideal state of facts which does not exist except in the imagination of its members. If employer and employed stood upon an equal footing; if the necessities of one were equal to the necessities of the other; if the abilities of both were equal—then freedom of contract would produce not only good but also just results. But no one with any knowledge of the world can affirm that these conditions exist. The condition of labor more nearly corresponds to that of a man who falls into a well, far removed from human habitation. After he has been there for a day without food and sees starvation staring him in the face, he attracts the attention of a stray passer-by by his cries for help. The latter comes up, but refuses to lower his rope and pull him out unless he receives five hundred dollars. The next day another man says he will help him out for one thousand dollars, but this offer is also declined. The third day, being nearly starved, he contracts to pay a third man fifteen hundred dollars for assisting him out of the well, and so regains his freedom. Labor has fallen into the well of poverty, and Capital stands on the brink and says in effect: "I did not put you there, and therefore I am justified in making the best bargain I can with you. In fact, I am forced to do so by the competition of some of my rivals who sell the same commodities. They screw wages down to the lowest point, and I can't compete with them unless I do likewise. I must either pay the same low wages, or retire from business, or become bankrupt."

It is precisely at this point that the pinch comes, which exerts a controlling influence upon the average employer. He cares nothing for fine-spun theories respecting the freedom of contract or personal liberty, but he knows from every-day experience that he can not pay high wages so long as there are even a few unscrupulous and avaricious employers in the same line of business who succeed in obtaining labor at low rates. He is forced to compete with them in the sale of his commodities, and the price of labor is a large item in the cost of their manufacture. Higher wages would eat up his profits, and drive him out of business or into bankruptcy. "If," he says, "some plan can be invented by which all my competitors will be obliged to pay high wages, then I have no objection to paying the same wages, for then we shall

all stand upon an equality with respect to the cost of labor. This will increase the cost of production; but, as the increase applies alike to all my rivals as well as to myself, I can make myself whole by raising the price of the finished product, as they will do the same."

The doctrine of the freedom of contract will never place the honest and generous employer upon an equal footing with the dishonest and avaricious employer in the cost of labor. Under it the latter will always obtain an advantage over the former. This doctrine, therefore, puts a premium upon the possession of these undesirable qualities. Moreover, under the law of competition in commodities, the honest and generous employer is forced to conform substantially to the rate of wages set by the dishonest and avaricious. This tendency is inherent in the wage system, and must increase, unless some remedy be found; for evil and grasping men can not be kept out of the ranks of employers, and only a few of them are required to depress wages below their fair value. This operates not only to the detriment of their employés, but also to the detriment of all other employés. Is it right that a few evil characters should commit this injustice upon labor, and control the vast majority of both classes? Should the State, or society in its organized form, permit them to do this wrong? It is submitted that it should not, and that some State agency should be devised to prevent or to remedy it.

About a year ago the writer published a pamphlet entitled State Regulation of Wages, in which he outlined a plan to remedy this difficulty. Its essential feature was the establishment of State Boards of Labor or Arbitration for the settlement of disputes between employers and employed, with power to fix the minimum wage and the maximum hours of work, upon the request of a certain proportion or number of either side. In determining the minimum wage, the board should not be controlled by the rate of wages now prevailing under the "iron law of wages" of supply and demand, but by what may be called the *golden rule of wages*, by which labor is entitled to receive a fair and just proportion of the wealth which it creates, irrespective of supply and demand. The minimum annual wage should be that required to support the average workman and his family in frugal comfort. The adoption of this plan would place all employers upon an equality in the cost of labor and relieve the generous employer from the competition of the avaricious one upon this large item in the cost of production. It is true that its adoption by a single State would not protect the employers of that State from the competition of their rivals in other States or foreign countries; but if the plan were found to work well in one State it would be speedily followed in other States; and, as to foreign competition, the tariff laws, if

not already sufficiently high to cover the difference in the cost of labor, could easily be made so.

If the people of a State see fit to establish such a Board of Labor or Arbitration for the settlement of labor disputes, it is no more an infringement of their personal liberty than is the establishment of courts of law for the settlement of legal disputes. In both cases the restraint is self-imposed, and may be thrown off at will by disestablishment. The object of both tribunals is the same, namely, that of settling disputes by the judgment of a body of disinterested and fair-minded persons, instead of leaving the stronger to overcome the weaker by force, or of allowing the cunning to victimize the innocent or simple. The experience of centuries has proved the practical utility of courts so composed in settling legal disputes, and every civilized nation has adopted the principle in one form or another. But with respect to labor disputes we are still in a state of barbarism, in which force, fraud, and cunning are always triumphant, and the matter is settled without regard to the merits of the case. Would any one advocate a return to the personal liberty of early days, when barons held their sway and settled disputes by the sword? Yet strikes and lockouts are industrial warfare, and are as barbarous methods of settling labor disputes as the baron's sword was of settling legal disputes.

At present the public does not realize that it has a vital interest in settling labor disputes peaceably, and in providing some competent tribunal for that purpose. The public is good-natured and easy-going, but it will not require many more large strikes and lockouts to arouse its ire. Take the case of a strike or lockout on a railroad or street-car company. These are *quasi*-public corporations, created by the State for the convenience of the public. They are subject to the control of the public; but if a strike or lockout arises, the public may be inconvenienced for days, weeks, or months, simply because there is no tribunal with power to settle the dispute. As the public has the power to remedy this evil, it has only itself to blame for its continued existence.

Nor is the public's interest in settling labor disputes confined to railroading, but also extends to manufacturing, mining, and other businesses. The public is injuriously affected by any act which seriously interferes with the production or distribution of wealth. Strikes and lockouts undoubtedly not only interfere with the production and distribution of wealth, but they also endanger the public peace and security of life and property.

The strong argument of employers is that their business is a matter of private concern, and that therefore they have the right

to conduct it as they see fit, without the State's interference. This is true to a great extent. For instance, the employer may decide what business he will adopt, where he will transact it, what goods he will manufacture, when and where and at what prices he will offer them for sale, what persons he will employ, and in many other ways act on his own judgment, uncontrolled by the State or the general public. But when disputes, strikes, and lockouts arise, it is only right that the State should require him to submit the matter to some superior power for determination and settlement. If the public has sufficient interest in a dispute between A and B respecting the ownership of an acre of land, or the liability of B to A for a pair of shoes, to justify the State in compelling them to submit to the decision of a court, it is extremely difficult to understand why the public has not sufficient interest in labor disputes, which frequently entail loss and suffering upon thousands of the public as well as upon the immediate parties to the dispute, to justify the State in requiring the parties to submit to the decision of a State tribunal.

Within the past ten or twelve years the principle of arbitration as a means of settling labor disputes has made considerable progress. The States of Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Missouri, and Montana have all established Boards of Arbitration. The new State of Wyoming has provided in its Constitution for the creation of such a board. By the act of October 1, 1888, Congress legalized a Board of Arbitration, to consist of three members, one to be chosen by each side and the third by the other two, with power to adjust differences between interstate railroads and their employés. Under these various boards some good results have been attained, some labor disputes have been settled, and some strikes and lockouts have been prevented. But the practical value and utility of these boards have been largely impaired by the provision in the law of their organization requiring *both* employer and employed to agree to submit the matter to the board, and also by the failure of the law to confer any power upon the board to enforce its decision or orders. In other words, under existing laws, these boards have jurisdiction only when both sides are willing, and even after the board has rendered a decision, the unsuccessful party may disobey its orders with impunity, as the board has no power to fine or imprison for disobedience. The result is that the board only acts in the small number of cases in which both sides believe themselves right, and never acts in the more numerous and important cases in which one side is conscious of the injustice of its demands. The board's decision has merely a moral but no legal force. The law should be amended in these respects so as to give the board jurisdiction upon the request of a certain number of either side,

and with power to enforce its orders—that is, the Labor Board should have the same power over the parties to a labor dispute that a court has over the parties to a legal dispute, and its jurisdiction should not depend upon the consent of both parties. Either side should possess the right to compel the other to submit the matter to the board; and if both sides refuse for a long time to submit to arbitration, and the public interests are endangered, it might be expedient to give a certain number of the public at large the right by request or petition addressed to the board to invoke its jurisdiction. With these powers exercised by a tribunal of disinterested persons it is believed that wages would be raised to the point of fairness, that the honest employer would be protected from the competition of the dishonest employer, that strikes and lockouts would cease, and that the eight-hour day would soon become an accomplished fact.

## MICA AND THE MICA MINES.

By C. HANFORD HENDERSON.

ONE can get little pleasure out of a science until one is tolerably familiar with its nomenclature and terminology. We should make even less than we do out of human history if we were not fairly familiar with the language in which it is written. If the words "institution," "government," "constitution" did not convey correspondingly definite ideas, we should be at a loss to interpret the pages of even our more obvious historians. In natural history it is much the same thing, and it is for this reason, I think, that so many make very little out of it. They never get to feel quite at home among the scientific terms which must needs be used. It may seem like insisting upon a very obvious truth to point out that, when we define or describe a thing in terms unknown to the hearer, we do not define or describe it at all; but nevertheless I believe that it is what Mill would have called a luminous platitude. It is certainly a commonplace more noticeable in the breach than in the observance.

A party of two or three are out on a tramp. Perhaps one of the number is a botanist. He is pretty sure to be besieged with questions: What is this?—What is that?—and all asked in evident good faith. One of the tramps picks up a little beach fern and rushes off to the Linnæus of the party to know what it is. Linnæus looks at it, and answers with all good intentions that it is a *Phegopteris dryopteris*. The non-botanical member thanks him, perhaps says, "Oh, is it?" as if it were a perfectly intelli-

gible thing to be a *Phegopteris dryopteris*, and in most cases goes away perfectly satisfied. Occasionally, however, it does occur to him that he is just as wise as he was before, and not one whit more so. These are not imaginary cases. It was from being several times in the position of the non-botanical member that led me to reflect that the function of a definition is to define. Now, who is to blame for this extreme haziness of intercourse, Linnæus or his friend? Perhaps both of them.

In the face of these experiences, it is difficult to answer the seemingly simple question, "What is mica?" To say that it is a unisilicate in which the predominant protoxide is potash and the predominant sesquioxide is alumina, is to say something that is fairly unintelligible to those who are not chemists, and something which even to those who are chemists gives only a bit of classification and partial composition, but in reality explains little about the mineral itself. Any answer that we can give is only satisfactory until we learn to push the question a step further. Gautama well expresses the difficuly when he says in the Light of Asia:

> "Shall any gazer see with mortal eyes,
> Or any searcher know by mortal mind,
> Veil after veil will lift—but there must be
> Veil upon veil behind."

But this is a difficulty which besets us on all sides when we question any of the thousand and odd minerals described in Dana, or for that matter when we put questions to Nature in any direction.

In the case of minerals we know enough to perceive that there is much yet unexplained which lies well within the domain of the knowable. But it is as difficult for the mineralogist as for the botanist to give even fair descriptions of the objects of his study, for he so soon runs against his brick wall when he comes to talk about either the physical or chemical properties of minerals. The processes of crystallization are as profound a mystery as the life process itself. We are much in the position of the zoölogists of the last century, who named and labeled their specimens without knowing the significance of their relationship.

The name *mica* is not that of a single mineral, but is a family cognomen, which includes a number of varieties. With the outward attributes of the family we are all more or less familiar, for under the common name of isinglass it forms a small part of the stock in trade of every householder. The family is one of some importance in the mineralogical hierarchy. All are shining members, and are alike in splitting into extremely thin leaves or plates; in being more or less transparent; in being highly elastic; and in having certain ingredients in common. There are seven

well-defined minerals* which lay claim to the family name, besides an extensive list of relatives which have been formed by alteration on exposure to air and water. The series runs from the compact, glistening mica found in granite and gneiss, through many gradations of hydrous micas, until we reach the ordinary soapstones and clays. But the name properly stops when the mineral loses its glistening surfaces, for then the Latin word *micare* (to shine) no longer applies. Our German friends call it *Glimmer*, a name whose significance is readily seen.

The importance of the mica family, however, does not depend alone upon its many varieties and numerous relatives. The micas are an essential ingredient in many of our most wide-spread rocks—such as the granites, gneisses, mica schists, and their relatives, which form the continental backbone in both the Eastern and Western worlds. These rocks in time run into each other through infinite gradations, just as the mica passes insensibly into the soapstone, so that we can nowhere find hard and fast lines in the mineral any more than we can in the biological world. If we wish, then, to think of mica correctly, we must picture to ourselves a long stem with many branches, and somewhere on this stem—perhaps midway between quartz and limestone—a group of closely related minerals of peculiar scale-like structure and glistening surfaces. We must think of minerals as momentary crystallizations in an ever-changing current of inorganic matter, and not at all as fixed and final forms.

When we submit the micas to chemical analysis, we find that they all contain a large amount of silica—whose common representative is ordinary quartz—combined with certain metallic bases, such as alumina, iron, magnesia, lime, and the alkalies (potash, soda, lithia, cæsia, and rubidia). No one mica contains all these—though there is some truth in the statement that the micas are silicates of almost everything—but the different varieties depend upon the nature and proportion of the metallic bases which combine with the silica. Thus, while common mica is in the main a silicate of potash and alumina, it also contains small quantities of other metals, such as sodium, magnesium, and iron.

There is a partial parallel here between the mineral and the organic world. Silica is, so far as we know, a compound made up

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* Phlogopite, a magnesia mica, commonly of bronze or copper color.

Biotite, or black mica, a magnesia-iron mica, of dark-green or black color.

Lepidomelane, an iron-potash mica, of black or green color.

Astrophyllite, a rare titanium mica, whose powder resembles mosaic gold.

Muscovite, or common mica, a potash-aluminum compound of varying color, white, gray, brown, green, and even violet or rose.

Lepidolite, or lithia mica, a mineral of pearly luster, and grayish to rose or violet color.

Cryophyllite, a very rare lithium mica, of greenish color.

of two elements, the gas oxygen and the hard, light, non-metal silicon. It is a substance that is almost omnipresent in the rocks of the world. In organisms, on the other hand, it is the carbon which is the chief element, and about which the hydrogen and oxygen and nitrogen group themselves. Silicon seems, then, to play much the same *rôle* in the mineral world that carbon does in the organic. In many respects the two elements themselves are similar. But the point of interest lies in their compounds. Fine, crystallized carbon, the diamond, is not readily altered. Nor are its simpler compounds with the elementary gases, such as carbon dioxide, marsh-gas, and cyanogen. But when the compounds become more complex, when carbon unites with all three of these elements, and the molecule contains many so-called atoms, it is correspondingly unstable. The highest development of this complicated organic structure is found in the human brain, and in the rapid changes which go on in these tissues we have, if not the cause of thought, at least its accompaniment. The quality and quantity of thought apparently depend upon the differentiation of these carbon compounds, and the consequent ease and rapidity with which they can decompose and recompose.

Now, we have in the mineral world at least a partial parallel to this general behavior, and one that is well illustrated in the members of the mica family. Silicon itself is never found alone, and the proximate reason for this is readily understood. It is a fundamental law of chemistry that, when two reactions are possible, that one will take place which will liberate the greater amount of heat. Apply this to silicon. When it unites with oxygen, the heat of combination is very great, greater than that produced by the combination of oxygen with carbon, and consequently this reaction would take place in preference to many others, even in preference to the oxidation of carbon. The point is admirably illustrated by the chemical reactions taking place in the Bessemer-steel process. The pig iron which is run into the converter consists in the main of metallic iron combined with carbon and silicon. When the blast of air bubbles through the molten metal, it is the silicon which first oxidizes. The flame escaping from the mouth of the converter is small and intensely hot. The spectroscope shows a predominance of the silicon lines. Then the carbon flame appears, less hot and more voluminous—the second choice of the oxygen. Finally, the iron itself begins to burn and the blast is discontinued. Bearing these facts in mind, we would never expect to find free silicon, and we are never disappointed. When the element combines with oxygen, in silica or quartz, we have a simple and extremely stable compound, as with the corresponding carbon compound. At a high heat and in the presence of metallic bases, the silica will readily enter into new combina-

tions, as in the processes of glass-making, but in the simple presence of air and water at ordinary temperatures, it remains unaffected through long ages. When the silica is united with a metal, such as aluminum, in kaolin and the ordinary clays, the compounds are still very stable, but they are less so than the simple oxide. When, further, there are several metals included in the compound, as in the mica minerals and their allies, the silicate decreases in stability as it increases in complexity, and we have, as with carbon, a readily decomposable compound.

The world has chosen rock as the symbol of stability, but it has not chosen very wisely, for the majority of rocks are anything but stable.

In the case of the mica family the readiness with which the minerals take up water and part with the more soluble of their components is shown in the many gradations by which they pass through the hydrous micas to the clays and soapstones. It is very noticeable in the mica regions themselves. A mica mine is, indeed, an instructive object-lesson in soil formations. One can almost see the decay of the crystalline rocks going on before one's eyes.

Were the micas only important as a rock constituent, they would doubtless receive very careful study by reason of the many interesting problems which their occurrence and alteration bring up, but in addition to this, their characteristic physical qualities, their transparency, elasticity, laminar structure, luster, comparative infusibility, and electrical non-conducting power, give them a number of applications in the arts, and make them the object of industrial mining. The mica of the market is in nearly all cases the common white mica or muscovite. From its chemical composition it is sometimes known as potash mica, to distinguish it from lithia and other micas, but these names are more common in the laboratory than in trade. Although mica is so widely distributed in Nature, it is only in a few localities and under well-defined conditions that it occurs in large enough plates to be profitably mined. Granite and gneiss both consist of a mixture of the three minerals, mica, quartz, and feldspar (another silicate of potash and alumina), but as ordinarily found, the mica is too thoroughly mixed with the other ingredients, and is in too small masses, to be available. It is only when fissures in the rock have been filled with very coarsely crystallized granite that the mica can be mined with profit.

Such fissure veins occur in a number of localties, notably in Siberia and Norway on the other side of the water; and in our own country, in New Hampshire, in North Carolina, in Wyoming, in New Mexico, in the Black Hills of Dakota, and probably in paying quantities in Alaska. Of late years the importation of

mica from the East Indies has been quite heavy and has closed many of the American mines. The recent tariff of thirty-five per cent is leading to their partial reopening.

All these mines are more or less alike so far as their natural features are concerned. The chief differences are artificial, and consist in the methods of mining and handling the mica. The mines of western North Carolina have been largely exploited and may well serve as a type.

As one travels across the State to the westward, one passes over three distinct belts of country: the lowlands, covered by recent alluvial deposits; the middle or Piedmont section, a low plateau underlaid by older sandstones and shales; and, last of all, the western or mountain section, in which the Appalachian system reaches its finest development, and in Mount Mitchell its culminating point. The trend of the rocks in this mountain section is pretty evenly northeast and southwest; they dip at angles which are generally forty-five degrees or over. There are a few mica mines to the east of the Blue Ridge, but the most of them and the best lie to the west. Once beyond this barrier, and evidences of mica abound on all sides. One sees the sunlight reflected from plates of mica on distant hill-sides, and the glitter of tiny scales in the bed of every brook. These look so much like gold that one is tempted to turn Argonaut, and try to bring again the golden fleece. For Colchis, it is easy to read Carolina. The talcose schists and slates of the eastern escarpment are here succeeded by the oldest crystalline rocks of the continent, belonging presumably to the Huronian or Laurentian period. There are giant upthrows of granite and gneiss, and these are full of fissures carrying the coarsely crystallized matrix in which the pay mica is found.

It must not be thought, however, that all these veins are alike profitable, or even that the same vein can be relied upon for any great distance, for that would be far from the experience of the practical mica-miner. It is indeed impossible, even after this lapse of time, when some of the mines have been worked intermittently for more than a quarter of a century, to reach any general conclusions as to what conditions are most favorable for a profitable mine. Old miners say that this or that indication is a sure sign of a good mine, but the shrewdest of them confess that mica-mining is pretty much like gambling. A certain amount is staked in the shape of labor and supplies, and one gets in return either hundreds of dollars' worth of mica, or perhaps only barren quartz and feldspar.

Many of the veins occur in a fine-grained black gneiss, which passes with the mountain miners under the name of "slate." The vein generally dips with the bedding of the gneiss, but occa-

sionally it changes abruptly and cuts across the strata. In some of the mines the vein does not come to grass, as the miners say, but only begins some distance below the surface. The veins vary in thickness from less than an inch to ten or a dozen feet, occasionally to as much as thirty or forty feet, but these instances are rare. In places the vein pinches out completely and is practically lost, or is cut off perhaps by a large mass of displaced country rock, known as a "horse."

The contrast between the vein stuff and its containing walls is very striking and often very beautiful. The "slate" is almost black, and is generally clean and glistening, while the vein itself is almost snow-white. This is due to the feldspar with which the fissure is filled. It breaks with a clean, smooth cleavage, and shows on such surfaces a brilliant, pearly luster. The dump-heaps around the mine-mouth are largely made up of this dazzling white feldspar. One is constantly tempted to fill every available pocket with the mineral, to the exclusion of other specimens really more interesting. Interspersed with the feldspar are masses of grayish-white quartz and occasional blocks of the coveted mica.

It would be of the highest value to know how these three minerals got into the vein and arranged themselves in their present form, but, as no direct observation is possible, we can only reason back from such facts as we are now able to observe. The fissures themselves are doubtless simple cracks formed by those shiftings and readjustments which are constantly going on in the surface rocks of the earth. The vein material has evidently been intruded from below and has come in a liquid or pasty condition, but just how it has come, and whether as a uniform mass which afterward separated into the different minerals, or as a mixture in which each mineral still preserved its own identity, we are quite unable to say. The most reasonable supposition is that the material came into the vein in a condition of aqueo-igneous fusion—that is to say, rendered liquid at a comparatively low temperature by the presence of water and great pressure—and that it was fairly homogeneous. The question as to which mineral separated first would seem almost hopeless. Yet there is quite strong circumstantial evidence to show that the mica was the first to form, for the mica is much more uniformly crystallized than either of the other two minerals, and frequently leaves the impress of its lamina on the crystals of quartz. After the mica, the feldspar probably separated; and, last of all, the silica that was left over after the formation of these two minerals, collected into crystals of quartz. This is what we would expect theoretically. The mica is only about half silica, the feldspar a little over two thirds, and the quartz manifestly nearly all silica. The minerals con-

taining the greater amount of metallic bases would naturally separate first.

The location of the mines has been largely accidental. So far as I have been able to learn, the first one opened was the Sink-hole mine in Mitchell County. The spot was marked by the existence of trenches, many hundred feet long in the aggregate, and in places fully twenty feet deep. Large trees growing on the *débris* indicated that the workings were very ancient. It was supposed that they had been for silver; and when the trenches were reopened at the close of the war, the search was for that metal and not for mica. Silver seems to dominate in the Carolinian dream of mineral wealth, when it is, of all such dreams, the one least likely to be realized. The search for silver being unsuccessful, the mines were again abandoned. The mica that had been thrown out was left on the dump, and soon advertised the real character of the mine. A stock-driver, passing that way, carried a block of it with him to Knoxville, where it attracted the attention of men acquainted with its value. They investigated the matter, emigrated at once to Mitchell County, and began systematic mining for mica. As the mineral was then selling for from eight to eleven dollars a pound, the rewards were considerable, and much enterprise was shown in the development of the industry. The first-comers had the easy and profitable task of simply preparing and shipping the mica that had been already mined, and they enjoyed the further advantage of an undisturbed market. So profitable an enterprise, however, soon attracted others. Many of the hands employed in the mines were also land-owners and naturally concluded, as soon as they had learned something of the business, that it would pay better to work for themselves. They began exploring their own plantations, and as these often contained several hundred or even several thousand acres, the ground for prospecting was extensive. It is a region in which the majority of the people are land-poor. The single-tax project would not be apt to meet with favor there.

Then, as now, the mountaineers were largely guided in their search by the ancient workings. These were probably made by the aborigines, and were also for the purpose of obtaining mica. The old workers could only penetrate as far as the rock was decomposed, and were obliged to stop as soon as solid ground was reached. The imprint of their stone implements may still be seen in the decomposed stuff at the sides of the opening. What these people used the mica for is still problematical. Large plates of it have been found in the mounds of Eastern Tennessee, and would indicate that it had domestic application, or was used for personal decoration.

In the absence of these archæological landmarks, there are other signs scarcely less unmistakable. On exposure to the atmosphere the feldspar is decomposed, the potash being washed out, and the kaolin left as an insoluble residue. If this be followed up, it is pretty sure to lead to mica, but one can not, of course, predict to what sort of mica.

In most cases the mining has been decidedly incidental in its character, and has been abandoned as soon as water was reached, or as soon as the yield of mica ceased to be immediately profitable. Other mines have had quite a history. Perhaps the most famous of the Carolina mines is the Clarissa, near Bakersville. It was opened soon after the Sink-hole, and is said to have produced more mica than all the other mines in the county combined. Its output is reckoned up in hundreds of thousands of dollars. The vein is from four to twelve feet thick, with an average of about six. It has been followed to a depth of over three hundred feet. The mine is now idle and full of water, although men who know it say that there is as much mica there as ever.

With labor at seventy-five cents a day, the primitive methods of mining are the more profitable. Steam drills have been introduced in a number of the mines, but have proved less economical than hand drilling. I do not know that the relation is strictly that of cause and effect, but their introduction has generally been followed by the closing of the mine. When the vein stuff has been blown down, it is an easy matter to separate the blocks of mica from the feldspar and quartz. When once obtained they are jealously guarded, for a clear block of mica of good size represents a value of many dollars. Each mine has its strong-room, solidly built of logs and constantly kept under lock and key. These blocks of mica are in the shape of rough hexagonal prisms (monoclinic), and if of any thickness are quite opaque. They vary in color from silver-gray and green to a rich, almost ruby brown. This last is known as "rum" mica, and sometimes commands an extra price.

The mica is seldom prepared for market at the mine itself, but is taken to a conveniently located glass-house. This generally means a transportation of several miles. Frequently the mines are on steep mountain-sides, and are only connected with the outside world by the roughest sort of trails. In this case the mica is "packed" down the mountain on the backs of men to the wagon-road in the valley below.

At the glass-house the mica is put into shape for shipment. The blocks vary greatly in size. One from the Wiseman mine, near Spruce Pine, is reported to have been six feet long by three wide. Pieces a yard in diameter have been obtained at the Ray mine, in Yancey County, and similarly large plates have been

found in Siberia, but these are exceptional. The average block is little larger than the page of a magazine, and is generally less than six inches in thickness. It separates very readily into sheets parallel to the base of the prism. It is estimated that this cleavage may be carried so far that it would take three hundred thousand of the mica plates to make an inch. It is needless to say, however, that such a thickness is not suitable for service in stoves and furnaces. The mica is generally split into plates varying from about one eighth to one sixty-fourth of an inch in thickness. In preparing these plates for market, the first step is to cut them into suitable sizes. Women are frequently employed in this work, and do it as well as, if not better than the men. The cutter sits on a special bench which is provided with a huge pair of shears, one leg of which is firmly fixed to the bench itself, while the movable leg is within convenient grasp. It is requisite that the shears shall be sharp and true, for otherwise they will tear the mica.

The patterns according to which the mica is cut are arranged in a case near at hand. They are made of tin, wood, or pasteboard, according to the preference of the establishment. Generally they are simple rectangles, varying in size from about four square inches to eighty. The following table, taken from actual use, will give some idea of the numerous sizes cut, and of the theoretical prices which correspond to them. The actual prices are at present about forty per cent less:

| Size. | Price per lb. | Size. | Price per lb. | Size. | Price per lb. | Size. | Price per lb. | Size. | Price per lb. |
|---|---|---|---|---|---|---|---|---|---|
| 1½ × 3 | $0 50 | 2 × 2½ | $0 60 | 2½ × 4½ | $2 00 | 2½ × 3 | $1 00 | 3 × 7 | $8 50 |
| 1½ × 3½ | 55 | 2 × 3 | 65 | 2½ × 5 | 2 40 | 2½ × 3½ | 1 20 | 3 × 8 | 8 75 |
| 1½ × 3½ | 60 | 2 × 3½ | 70 | 2½ × 5½ | 2 50 | 2½ × 3½ | 1 35 | 3 × 9 | 9 00 |
| 1½ × 3½ | 65 | 2 × 3½ | 80 | 2½ × 5½ | 3 00 | 2½ × 3½ | 1 50 | 3½ × 3½ | 3 50 |
| 1½ × 4 | 75 | 2 × 3½ | 90 | 2½ × 6 | 3 40 | 2½ × 4 | 1 75 | 3½ × 3½ | 4 00 |
| 1½ × 4½ | 85 | 2 × 4 | 1 10 | 2½ × 6½ | 3 65 | 2½ × 4½ | 2 25 | 3½ × 3½ | 4 50 |
| 1½ × 4½ | 1 00 | 2 × 4½ | 1 20 | 2½ × 6½ | 3 90 | 2½ × 4½ | 2 75 | 3½ × 4 | 5 00 |
| 1½ × 4½ | 1 25 | 2 × 4½ | 1 40 | 2½ × 7 | 4 25 | 2½ × 4½ | 3 50 | 3½ × 4½ | 5 25 |
| 1½ × 5 | 1 50 | 2 × 4½ | 1 50 | 2½ × 2½ | 70 | 2½ × 5 | 4 50 | 3½ × 4½ | 5 50 |
| 1½ × 5½ | 1 90 | 2 × 5 | 1 75 | 2½ × 2½ | 75 | 2½ × 5½ | 4 75 | 3½ × 4½ | 6 25 |
| 1½ × 6 | 2 40 | 2 × 5½ | 2 40 | 2½ × 3 | 85 | 2½ × 5½ | 5 25 | 3½ × 5 | 7 25 |
| 1½ × 2 | 50 | 2 × 6 | 3 00 | 2½ × 3½ | 95 | 2½ × 6 | 5 75 | 3½ × 5½ | 7 50 |
| 1½ × 2½ | 50 | 2 × 6½ | 3 50 | 2½ × 3½ | 1 00 | 2½ × 6½ | 6 25 | 3½ × 5½ | 7 75 |
| 1½ × 2½ | 50 | 2 × 7 | 4 00 | 2½ × 3½ | 1 20 | 2½ × 7 | 6 75 | 3½ × 5½ | 8 00 |
| 1½ × 2½ | 50 | 2 × 7½ | 4 25 | 2½ × 4 | 1 30 | 3 × 3 | 1 80 | 3½ × 6 | 8 50 |
| 1½ × 3 | 60 | 2 × 8 | 4 50 | 2½ × 4½ | 1 60 | 3 × 3½ | 2 15 | 3½ × 3½ | 4 50 |
| 1½ × 3½ | 65 | 2½ × 2½ | 50 | 2½ × 4½ | 2 25 | 3 × 3½ | 2 60 | 3½ × 3½ | 5 00 |
| 1½ × 3½ | 75 | 2½ × 2½ | 55 | 2½ × 4½ | 2 75 | 3 × 3½ | 3 00 | 3½ × 4 | 5 50 |
| 1½ × 3½ | 90 | 2½ × 2½ | 60 | 2½ × 5 | 3 50 | 3 × 4 | 4 00 | 3½ × 4½ | 5 75 |
| 1½ × 4 | 1 00 | 2½ × 3 | 70 | 2½ × 5½ | 3 60 | 3 × 4½ | 4 75 | 3½ × 4½ | 6 50 |
| 1½ × 4½ | 1 10 | 2½ × 3½ | 85 | 2½ × 5½ | 3 75 | 3 × 4½ | 5 50 | 3½ × 4½ | 7 00 |
| 1½ × 4½ | 1 25 | 2½ × 3½ | 95 | 2½ × 6 | 4 25 | 3 × 4½ | 6 00 | 3½ × 5 | 7 50 |
| 1½ × 4½ | 1 40 | 2½ × 3½ | 1 10 | 2½ × 6½ | 4 50 | 3 × 5 | 7 00 | 3½ × 5½ | 8 25 |
| 2 × 2 | 50 | 2½ × 4 | 1 25 | 2½ × 7 | 5 00 | 3 × 5½ | 7 50 | 3½ × 6 | 8 75 |
| 2 × 2½ | 50 | 2½ × 4½ | 1 50 | 2½ × 8 | 5 50 | 3 × 6 | 8 00 | 3½ × 6½ | 8 75 |
| 2 × 2½ | 50 | 2½ × 4½ | 1 75 | 2½ × 2½ | 85 | 3 × 6½ | 8 25 | 3½ × 7 | 9 00 |

| Size. | Price per lb. | Size. | Price per lb. | Size. | Price per lb. | Size. | Price per lb. | Size. | Price per lb. |
|---|---|---|---|---|---|---|---|---|---|
| 3½ × 8 | $9 25 | 4 × 5½ | $8 00 | 4½ × 5 | $8 25 | 5 × 8 | $10 25 | 6 × 9 | $11 00 |
| 3½ × 9 | 9 50 | 4 × 5½ | 8 50 | 4½ × 5½ | 8 75 | 5 × 9 | 10 50 | 6 × 10 | 11 50 |
| 3¾ × 3¾ | 5 50 | 4 × 6 | 9 00 | 4½ × 6 | 9 25 | 5 × 10 | 11 00 | 7 × 7 | 10 75 |
| 3¾ × 4 | 5 80 | 4 × 6½ | 9 25 | 4½ × 6½ | 9 50 | 5½ × 5½ | 9 25 | 7 × 8 | 11 00 |
| 3¾ × 4½ | 6 25 | 4 × 7 | 9 50 | 4½ × 7 | 9 75 | 5½ × 6 | 9 75 | 7 × 9 | 11 25 |
| 3¾ × 4½ | 6 75 | 4 × 8 | 9 75 | 4½ × 8 | 10 00 | 5½ × 7 | 10 25 | 7 × 10 | 12 00 |
| 3¾ × 4¾ | 7 25 | 4 × 9 | 10 00 | 4½ × 9 | 10 25 | 5½ × 8 | 10 50 | 8 × 8 | 12 00 |
| 4 × 4 | 6 25 | 5½ × 4½ | 6 75 | 5 × 5 | 8 50 | 5½ × 9 | 10 75 | 8 × 9 | 12 50 |
| 4 × 4½ | 6 50 | 4½ × 4½ | 7 25 | 5 × 5½ | 9 00 | 6 × 6 | 10 00 | 8 × 10 | 13 00 |
| 4 × 4½ | 7 00 | 4½ × 4¾ | 7 75 | 5 × 6 | 9 50 | 6 × 6½ | 10 25 | | |
| 4 × 4¾ | 7 50 | 4½ × 5 | 8 00 | 5 × 6½ | 9 75 | 6 × 7 | 10 50 | All larger at special prices. | |
| 4 × 5 | 7 75 | 4½ × 4½ | 7 50 | 5 × 7 | 10 00 | 6 × 8 | 10 75 | | |

The cutter selects the pattern which will cut to the best advantage, lays it on the sheet of mica, and then, holding the two firmly together, trims off the edges of the mica to make it correspond with the pattern. She puts both mica and pattern in their proper place in the case before her. Then she takes up another piece of mica, and finding the best pattern, proceeds to shape the sheet as before. In this way the rough plates of mica are reduced to uniformity and are sorted as they are cut. When the cutter completes her task, she has all the mica piled away in little bundles under their corresponding patterns, while the scrap falls in a glistening heap on the floor.

The cleaning process comes next. The cleaner sits directly in front of a window and must examine each sheet of cut mica by holding it up between her eyes and the light. If there be any imperfections, and there nearly always are, they must be removed by stripping off the offending layers of mica until a clear sheet remains. The cleaning is done by means of a sharp penknife—and considerable discretion. It is quite easy to tear away the entire sheet and have nothing left for one's trouble. Both the cutting and cleaning are tiresome routine operations, yet there is a certain fascination about tearing the mica to pieces that few have philosophy enough to resist. One soon becomes absorbed in the task of seeing just how thin a sheet of mica can be separated, and before one realizes it an hour or more is gone.

Finally, the cut and cleaned mica is put up in pound packages and is ready for the market.

There is an enormous waste in the processes of preparation. One hundred pounds of block mica will scarcely yield more than about fifteen pounds of cut mica, and sometimes it is even less. The proportion varies, of course, with different localities.

The chief use of the cut mica is in stoves, and its comparative cheapness has made possible the luminous—not to say artistic—wonders which constitute the latest and most cheerful creations of the stove-men. In Siberia the sheets of mica are still some-

times used in windows, as they were in the seventeenth century in Philadelphia, when glass was a luxury in the colonies. The sheets are also used in the peep-holes of smelting furnaces, in lanterns, in shades, and in the port-holes on board naval vessels, where the vibrations would soon demolish less elastic glass. Mica is an excellent non-conductor, and of recent years has been cut to some extent into narrow strips for use in the construction of dynamos.

The scrap mica was formerly thrown away, with the exception of a small quantity used as a lubricating material, but it has recently found a market in several new directions. Old waste heaps are being bought up, for a few dollars a ton, and their contents cleaned by being passed through a rough mill. This is simply a rotating cylinder of coarse wire screen with its axis slightly inclined to the horizontal. The scrap is fed into the upper end of the cylinder, and slowly discharges itself from the lower end. As it makes its way from end to end, the sand and trash are supposed to fall through the meshes of the screen. The cleaned scrap is then shipped to Richmond, where it is ground into a coarse powder and distributed to the various industries requiring it. Large quantities are used in the manufacture of wall-paper. The mica produces a sparkling surface which is thought to be decorative, but at best the effect is somewhat bizarre. Considerable amounts are used to produce the snow effects on Christmas cards, and in stage scenery and other tinsel; while smaller packages, under the name of diamond dust, are sold as powder for the hair. Much of the ground mica is sent to France, and this, oddly enough, when the East Indian sheet mica is pressing our own pretty heavily in the home market.

The Latin world used the mica dust to strew over the Circus Maximus, while mediæval Europe knew the golden and silver scales as cat-gold and cat-silver.

But to go back again for a moment from the glass-house to the mines themselves, there is much of interest in the rare and beautiful minerals associated with the mica. Some of the mines are quite noted for these by-products and are as attractive to a lover of color as to the mineralogist. The mica itself is often the carrier of curious forms. Frequently a mineral makes its way between the laminæ of the mica, and is thus forced to grow horizontally instead of normally in three directions. This gives us curious dendritic or tree-like forms which come out finely on holding the mica up to the light. The oxide of manganese is most prone to get caught in this way, and gives delicate tracery of dark brown or black. Sometimes it is a garnet which is thus entrapped, and then we have a brilliant little hexagonal plate of ruby glass, very beautiful and very gem-like. By carefully taking off the outer

sheet, we can get the garnet-plate set in mica, and it makes a specimen well worth preserving. Less frequently one finds a thin layer of quartz imprisoned between the mica, or a thin layer of the transparent glassy feldspar known as sanidin. Sometimes the mica itself is microscopically striated, and plays queer tricks with the light, giving iridescent films that might easily be mistaken for soap-bubbles.

But the feldspar is the most promising matrix for the mineral hunter. At the Cloudland mine it is well penetrated with the greenish, yellowish, and bluish hexagonal prisms of the beryl. The precious form of this mineral, the emerald, is seldom or never found in the mica mines. There is, however, an intermediate variety known as the aqua marine, which occurs in the mines around Spruce Pine, and is somewhat esteemed as a gem. As the name indicates, it is of a light sea-green color. It is perfectly transparent, and when well cut makes a quiet but really beautiful gem-stone. Clear crystals of aqua marine are exceedingly rare. It comes commonly as a part of the opaque crystal of beryl.

Intimately associated with the beryl are plentiful sprinklings of blood-red garnets, and the two colorings against the pure white background of the feldspar make a very effective combination. Garnets are generously distributed in nearly all the mica mines, and add much to the beauty of these mineral masses. One day at the Cloudland mine, a large mass of feldspar was blown down, and there in the center of the white and standing face of the vein was a blood-red spot at least six or seven inches in diameter. A giant garnet had been cut squarely in two by the blast, and the blood-red spot was a cross-section of what remained.

In other mines, such as the Tolly Bend in Yancey County, the white feldspar is occasionally covered with patches of dainty pink. It is the mineral rhodonite, a silicate of manganese, and is as delicate as a peach-blow vase.

There are also other accessory minerals which are less striking in appearance, but of greater scientific interest on account of their rarity. Such are euraninite, gummite, columbite, and samarskite, containing the rare metals uranium, columbium, yttrium, tungsten, tantalum, and their allies, which are curiosities even to the chemist. At Spruce Pine, one gets excellent specimens of uraninite, the oxide of uranium. It is a heavy black mineral with a frequent orange-yellow coating of another uranium compound, gummite. The miners take considerable interest in finding the mineral, as it is worth something like a couple of dollars a pound, and it takes a very small quantity to make a pound. The oxides of the metal are used to produce black and yellow col-

ors on glass and porcelain. The peculiarly fine black of Haviland china is due, I believe, to uranous oxide.

The Ural Mountains are the collecting-grounds for the cabinets of Europe. In no other district can one find so many varieties of minerals within the same area. The mountains of western North Carolina are in many respects similar. They probably yield a greater number of rare minerals than any other region in America, and are therefore a favorite tramping-ground for collectors. At the smallest cross-roads post-office one hears of the visit of some well-known mineralogist. Nearly every mountaineer has a few specimens in his treasury, and generally he knows the names of the more characteristic varieties, particularly if they have a marketable value. It is not safe, however, to rely very implicitly upon his classification, for his knowledge is of the most superficial sort.

As commonly taught in our schools and colleges, and as commonly apprehended by students outside, a knowledge of mineralogy consists of a more or less definite familiarity with several hundred minerals, and an ability to recognize the more common varieties on sight, or by means of some readily applied physical test. It is largely a knowledge of separate and unrelated facts, a catalogue, one might almost say, and not yet a body of well-organized truth. We have gathered part of the material of a fine science, and eminent men are now at work building this material into a coherent whole. The curious facts of paragenesis, or the characteristic associations of minerals, and the many problems presented by substitution and alteration, are being carefully investigated. The mysteries of crystallization are commanding attention. The progress along these lines is very encouraging. But a great amount of work still remains to be done. One who comes to the study of minerals at this particular juncture will find it pleasurable, even as a study of separate facts, but he will feel, I think, that a greater pleasure remains for him when these results have been still further co-ordinated. We are still waiting for our Darwin.

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STATISTICS concerning the influence of the style of living on stature, collected by M. G. Cartier from among the conscripts at Évreux, France, go to confirm the conclusions that other authors have drawn on the subject. Persons who are supposed from their occupations to have been brought up under good hygienic conditions and comfortable circumstances—students, farmers, etc.—are generally of larger than average stature; while persons ill-fed, poorly clothed, or who have grown up in an unfavorable medium—workers in metallurgy, weavers, etc.—are smaller. Consequently, if "the race fixes an ideal mean round which individuals oscillate," the latter are especially influenced by the conditions of the medium, alimentation, exercise, and comfort.

## INCALCULABLE ACCIDENTS.

By WILLIAM A. EDDY.

WHEN we consider the quantity of metal and the jars and strains to which it is subjected as railroad trains move at high speed, it becomes difficult to estimate the effects of accidents and to think of a way to evade injury. When caught between trains rapidly passing each other it is claimed that if the incautious pedestrian remain standing the result will be disastrous, and that safety is assured only by lying down. This peculiarly perilous situation illustrates a simpler phase of the complications that may arise when an accident is imminent, in which the danger may be principally due to the fact that the noise and interposition of one train conceal the presence of another.

The surprising and unexpected nature of some railroad accidents was exemplified in the experience of the engineer of a passenger train which was moving at the rate of about forty miles an hour. He felt a jar and heard a terrific clatter beneath his locomotive. At the same time he was astonished to find that the seat on the other side of the engine cab where the fireman usually sat had been torn away, and the fireman thrown backward and left insensible. The engineer instantly knew that one of the bars connecting the driving-wheels of his locomotive had broken. The partly detached piece of steel beat against the cab with severe blows caused by the rapid revolutions of the wheels. He jumped to his feet to escape injury, just as the bar on his side of the locomotive broke also and tore away the seat which he had vacated. The crippled locomotive was then derailed, causing general destruction of the running gear and woodwork of the cars.

This derangement in the mechanical structure of a locomotive occasionally happens, and it is one of the possible accidents that every locomotive engineer must guard against. It is clear that familiarity with special machinery sometimes lessens the fatality due to an accident, because the resulting effects have been looked for during many years, and the action to meet the conditions decided upon. But the complication is increased by the fact that each accident may be unprecedented. For example, at another time the side-bar broke away from the driving-wheels altogether, and, striking against a jutting point of rock, bounded beneath the train, which was under full head-way. This long, powerful piece of steel then flew along the track under the train and pierced a hole through the floor of the rear car. Meantime the brasses and some of the more delicate machinery on the forward part of the locomotive were torn away and, falling on the track or rails, threw off the last four wheels of the rear car, which was dragged

in a slanting position, plowing up the gravel, for about a thousand feet along the edge of a high embankment. The occupants of that car never forgot the awful sensation, like that of a violent earthquake with its resulting uncertainty of footing. A striking characteristic of this accident was that the engine and forward car were not thrown from the track. Another accident of this kind, equally unexpected, took place under somewhat similar conditions, when one of the driving-wheels burst with terrific explosive force, a solid piece of the iron crashing through the woodwork of a passenger car, after having shattered the glass of a door. This ponderous missile shot along the aisle between the car seats, unpleasantly near the heads of the passengers.

The sign on many car doors notifying passengers not to ride on the car platforms calls attention to a danger which is more real than may be at first supposed. Some people who easily lose their balance may be thrown off a train, owing to the sudden jar of the cars at the beginning of a sharp curve, and the same effect may be brought about by the stopping and starting caused by coupling cars. In one such instance a man was thrown from the rear platform as the train made a jerking movement forward. There is also the possibility of a fall due to dizziness or momentary faintness. But probably the most remarkable case recently recorded occurred during a very high wind when a passenger was blown from the platform of a car which was running across the wide, windy expanse between Jersey City and Newark, New Jersey.

There is marked danger in trying to board a moving train, as shown by repeated accidents; yet so irresistible is the temptation to do this that it would be difficult to find a man who has not taken the risk. The car steps, as related to the position of an ordinary station platform at the level of the rails, are too high to be easily gained, and the rails over which the wheels of the car are to pass are nearer the edge of the car steps than is generally supposed. If, owing to miscalculation, haste, or a stumble, the passenger's foot is placed under instead of upon the step, the result may be fatal, because the movement of the body when swinging from the perpendicular railing at the corner of the car is then toward a position beneath the car platform. It is probably safer to jump from a rapidly moving train than to board the same train. The extent of the peril in leaping from a moving car obviously depends upon the amount of skill shown in alighting upon ground that slants away from the track. Of course, the many serious accidents caused in this general way suggest the radical importance of waiting for a train to stop.

The rules pertaining to the safety of passengers using the great transportation lines seem at times needless. But the move-

ments of people who are distracted by trouble, who are absent-minded, excited, mentally disordered, almost crazed by an amazing success as well as by an equally amazing failure, may be characterized by incalculably erratic action, even if the action be decidedly exceptional. Such people may have little more than the power of ordinary locomotion. In many instances, owing to the unprecedented nature of the occurrence, the individual at his best can not cope with the conditions. Some accidents may take place only once in a lifetime, and the person threatened is necessarily unable to instantly decide upon the wisest course.

Accidents may be dealt with coolly by the professional man, or the coroner who attends like cases. The growing complications of modern life are such that the highest form of natural shrewdness is almost inoperative under these rare circumstances when compared with experienced intelligence.

The modern railroad train, with its tremendous momentum, calls for a greater number of mechanical engineers of superior ability whose ingenious constructive power shall further lessen not only the danger but the amount of destruction caused by railroad accidents. Prevision of the effects of an accident may involve the elaborate calculations necessary to the solution of an intricate mathematical problem. In fact, the contingent or possible results in a given instance suggest the importance of long and careful training. Undoubtedly, with the lapse of time, and with wider experience, the imperfections in railroad construction and material will steadily decrease.

The accidents from contact with electric-light wires that carry a deadly current are well known, but the complex nature of these accidents demands special attention. Sometimes the attempt to close an iron door or an iron window shutter is at once followed by a severe electric shock, if not by serious injury. The men who repair ordinary telegraph wires have learned to be cautious because of the possible presence of a deadly current. An operative who was accustomed to the work of readjusting dangerous wires was killed because, unknown to him, an apparently disused, rusty wire was charged with intense electric force, as evinced by the fact that a metal cornice, wet with rain, carried the current from the wire through his body. A somewhat similar accident occurred to a skilled electrician who was connecting one wire with another on a switchboard. He lost his balance while on a step-ladder, and, as he put out his hand to save himself, he by chance touched another wire, and this completed a circuit that killed him instantly. Still another phase of this kind of accidental death from electricity was seen in New York city when an Italian, who was cleaning a window, completed a circuit from his hand through his body, the current penetrating the sole of his shoe which rested

upon a metal surface. A like accident, singularly fatal, happened to one of two clerks who had lifted a metal show-case to carry it into a store. The metal top of the case touched the metal extension of an arc electric lamp that had been left hanging too near the pavement. One of these clerks, moving hurriedly under the strain of the burden, chanced to step upon an iron cellar grating which caused the electric current to kill him instantly. The other clerk, who was lifting his part of the weight, stood upon the ordinary pavement and so was not injured. The metallic frame of the show-case had transmitted the current.

Some very serious injuries have been caused by an attempt to brush away an electric-light wire that dangled against the head of the passer-by. The muscles of any one who is unfortunate enough to grasp such a wire contract with uncontrollable persistence, and the electric current burns with an effect resembling that of white-hot iron.

The innumerable electric appliances, which are already beginning to compete with those run by steam, must increase the number of accidents. Rapidly growing power is at present accompanied by rapidly growing risk—a condition to be expected during early stages of advancement. But relative safety will doubtless be attained through the skill of an army of specialists who will be divided and subdivided into a greater number of groups as the new combinations multiply. Herbert Spencer's doctrine of the increase of heterogeneity during certain stages of evolution is thus reaffirmed in this age of mechanism. Yet there is every reason to expect that the development of intelligence will steadily eliminate the dangers arising from haste in construction. The loss and inconvenience which may be experienced while waiting for absolute safety should not be overlooked. In fact, prolonged delay is neither practicable nor desirable.

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In his introductory lecture on the Anthropological History of Europe, Dr. Beddoe inclines to the modern view which regards Europe as the original home of the Aryans. He also discusses in a novel manner some of the causes which may be supposed to produce changes of physical type. Incidentally he records his opinion that a process of selection, which may be called natural, works against the perpetuation of certain types in our cities. He also remarks that more evidence exists than is generally known of the deteriorative effect of malaria on physical type.

The Antarctic Fund of the Australian Association for the Advancement of Science has grown to £14,044, leaving only £1,000, or $5,000, to raise it to the £15,000 that are sought to complete it. It is thought that this remaining amount will be furnished by the colonial governments. As at present arranged, the expedition is expected to arrive in September, 1893, at its last coaling port and starting-point in the southern hemisphere.

# TOBACCO AND THE TOBACCO HABIT.

By M. JULES ROCHARD,
OF THE FRENCH ACADEMY OF MEDICINE.

THE use of tobacco prevails throughout the whole world. Smokers alone are numbered by hundreds of millions. A million and a quarter acres of the earth are devoted to the cultivation of the plant, and the taxes on it alone in France amount to three hundred million francs (or sixty million dollars). A custom so general, a habit that has been maintained so long in the face of constant attacks upon it, should be considered seriously. It should be studied from every side, and the various elements of the question should be subjected to a complete analysis by the means of investigation now at our disposal, for it is a scientific problem of the first order. While it is of moral and philosophical interest, and its social consequences are within the province of economists, it is for science, physiology, and hygiene to furnish experimental data as the basis for their deductions.

A proper study of the subject should be made with an independence of prepossession which it is not easy to find. Persons who have never smoked will talk of tobacco as the blind talk of colors; smokers have a fondness for their habit, while those who have been obliged to give it up are prejudiced on the other side. I am one of the reformed smokers. After having abused tobacco for about fifty years, I was compelled to abjure it. I fought my ground inch by inch, and yielded only to an absolute necessity. Knowing what the reformation cost me, I have not tried to make proselytes; but I intend to say what I believe is true upon a question which I have studied well, and on which I am not lacking in personal experience.

The tobacco plant belongs to the order *Solanaceæ*, and constitutes a genus (*Nicotiana*) named after Jean Nicot. It is cultivated through the whole world, and succeeds equally in the temperate zone and the intertropical regions. Two species are cultivated: common or large tobacco (*Nicotiana tabacum*) and small tobacco (*Nicotiana rustica*). The first species is the most widely diffused. It is a large and fine-looking annual plant, growing to a height of about six feet. It bears large alternate leaves of a glaucous-green color, and is tipped with a cluster of elegant flowers having a pale-rose corolla and a persistent five-parted calyx. Small tobacco does not exceed twenty inches or two feet in height. Its leaves are thick, soft, dark-green, and viscously hairy. The terminal inflorescence comprises clusters of flowers composed of cymes. The pale-yellow corolla, a little greenish, is supported by a campanulate calyx, covered with glandular hairs and terminat-

ing in uneven teeth. The genus *Nicotiana* includes some fifty other species, mostly natives of America, but some of Australia and the islands of the Pacific Ocean. Of these, some fifteen or twenty species are cultivated and give rise to different foreign tobaccoes, the taste and properties of which are varied. A few species, remarkable for the richness of their colors and their graceful growth, are cultivated as ornamental plants in gardens.

Tobacco leaves contain principles common to all vegetable substances—such as starch, cellulose, sugar, organic acids, and salts—principles soluble in ether, nitrogenous substances, and a peculiar alkaloid to which the plant owes its special qualities, called *nicotine*. This alkaloid, discovered by Posselt and Remann, was isolated by Vauquelin in 1809. It is an oily liquid, transparent and colorless, which becomes brown and thick in the air by absorbing oxygen. Its acrid and virulent odor is like that of tobacco; it has a burning taste, and its vapor is so irritating that breathing is painful in a room where a drop of it has fallen. It is very hygrometric, and soluble in water, alcohol, and ether. It combines directly with acids, with the evolution of heat. It is found as a malate in the leaves. The different kinds of tobacco do not contain the same quantities of it. The black, unctuous tobacco of the Antilles, the pronounced savor, ready burning, and white ash of which make it in demand among experienced smokers, contains much more nicotine than the light, fragrant tobacco of the Levant. The quantity of it increases with the development of the plant, and varies according to the thickness of the leaves. The thinner-leaved plants contain less of it. The fermentation to which tobacco is subjected in manufacturing volatilizes a part of the nicotine and substitutes ammonia for it. Consequently, there is less nicotine in tobacco prepared for consumption than there was in the dry leaves before the preparation. Combustion destroys about three quarters of this. According to M. Pabst, the smoke of five grammes of tobacco yields about three milligrammes of nicotine; but it contains a number of other principles besides, the enumeration of which here would not be interesting. Nicotine is the active principle of tobacco, as atropine is of belladonna and morphine of opium; but there are other poisons among the substances united with it. The less volatile ones condense during combustion, and produce a brownish empyreumatic liquid, a kind of coal-tar of tobacco, a part of which oozes through porous pipes, and the whole of which is retained in the water of nargilehs.

Among the volatile principles that pass into the smoke along with nicotine are hydrocyanic acid and carbonic oxide. Dr. Grehant has shown that a notable quantity of them is absorbed by rapid smokers swallowing the smoke, and the gas passes into the

stream of the circulation. These facts are of considerable importance in view of practical consequences, and go far to explain the accidents that sometimes occur after one has passed several hours in a medium saturated with tobacco, even without smoking, and the phenomena of intoxication which are produced by eating food that has remained for a long time in a similar atmosphere.

Tobacco is a poison, as are most of the *Solanaceæ* and many plants which medicine daily utilizes. Its properties have been studied in our time with all the rigor of the experimental method, verified by clinical observation. We can no more than present the principal results of the investigation here. The decoction of tobacco destroys animal life in a time short in proportion to the strength of the dose. The phenomena preceding death are like those produced by other toxic alkaloids, and are identical with those exhibited by man in a similar condition, which doctors have had too frequent occasion to observe. Sometimes convicts or sailors swallow their quids, or fools drink on a wager a glass or two of the empyreumatic juice that flows from old pipes, or the poison is swallowed by mistake, as when snuff is taken for coffee or tobacco leaves are mixed with orange leaves. Cases of malicious poisoning are more rare; but the poet Santeuil died, according to Merat, in horrible suffering after having drunk a glass of wine in which Spanish tobacco leaves had been put. Mortal poisoning is, however, rarely brought about when tobacco is taken by the mouth, for it is nearly always rejected by vomiting before it can produce its worst effects; but the results of intestinal administration are different. The intoxication is then most usually the result of a medical error. The decoction of tobacco is still given sometimes as an injection in cases of asphyxia by submersion or of strangled hernia, and, if the dose is too large, death may result. Orfila cites four cases that were fatal in doses ranging from eight to sixty-four grammes. One patient died in fifteen minutes, and the one who held out longest at the end of two hours. Eight grammes do not form a toxic dose, but the case cited by Orfila was one of an infant. From fifteen to thirty grammes are required to kill an adult. Tobacco may also poison through the lungs. Cases are mentioned of persons who died from sleeping in a room filled with fermenting leaves; others, worthy rivals of the bettors just now spoken of, died after executing wagers that they could smoke an improbable number of pipes without intermission. The skin itself may serve as a channel for the introduction of the toxic principle. Accidents of this kind were not rare when diseases of the skin were treated with pomades or liniments of which tobacco was the base. Murray reports an observation of three infants who were taken with vomitings and vertigos, and died in convulsions within twenty-four hours after

having their heads rubbed with a tobacco ointment. Cases are recorded of smugglers who died after having covered the bare skin of their whole body with tobacco leaves which they were trying to introduce fraudulently. Ferdinand Martin has related the case of a lady afflicted with lumbago who applied flannels dipped in a decoction of smoking tobacco to the ailing part. Her pains were promptly subdued, but she soon felt all the phenomena of intoxication by nicotine, and did not recover from it for three days. Poisoning by tobacco generally occurs by accident or mistake. It is rarely tried criminally, probably because the toxic properties of the drug are not reliable enough. Assassins prefer the alkaloid itself, the effects of which are much more prompt and more terrible than those of the plant. By whatever method it is administered in experiments, the animal is slain. Two drops are enough to kill a large dog; eight drops will kill a horse in four minutes. Under its effects he rages, prances, writhes, falls down, and dies in convulsions. "This alkaloid," says Claude Bernard,* "is one of the most virulent poisons known, and a few drops of it on the cornea of an animal will kill it instantly. Nicotine, apparently sympathetic in its effects, in its action is very much like prussic acid." The action of this principle is so subtle that it can not be analyzed unless the drug is administered in minute doses and very dilute solutions. There is then observed the phenomenon—which goes far to explain the facility with which one is habituated to the use of tobacco—of the rapid development of tolerance of gradually increasing doses. This has been demonstrated by Traube, who, with the twenty-fourth of a drop of nicotine subcutaneously injected, obtained very marked effects on the first day. The next day, on the same animal, it took a whole drop to reach the same result, and at the end of four days five drops were necessary. A similar tolerance is observed in man for hypodermic injections of morphine; but one does not get accustomed to digitaline or strychnine.

When nicotine is administered in doses weak enough to permit an analysis of its effects, almost the same phenomena are witnessed as with the whole plant. In the cases of poisoning already mentioned, there came on at the beginning extreme anguish and agitation, with sensations of burning heat in the pit of the stomach. Respiration was accelerated and the pulse was slackened; then came vomiting and purging, vertigo, and faintness. The face grew pale, the skin was covered with a cold sweat, the head was confused, and the patient fell into a deep stupor, with cries, general trembling, and convulsions. This agitation gives place

* Leçons sur les effets des substances toxiques et médicamenteuses. Paris, 1857, p. 397.

to paralysis and insensibility; respiration is impeded, the pulse declines to a mere thread, and the patient dies in syncope.

When the patient resists the attack, as is most frequently the case, the evolution of the symptoms described above is arrested, and the sufferer comes out of his comatose condition with a violent headache, extreme weakness, and a gastric disturbance which it requires a considerable time to allay.

The effects produced by the habitual use of tobacco differ according to the way it is consumed. They have not been much observed except among smokers, who are most noticed because of their number. Then their habit is open; the smoke goes everywhere, and it causes inconvenience to others; while the more discreet snuff-taker can hide his snuff-box, and annoys with the smell of tobacco only those who come too near him.

Beginners at snuff-taking require, like smokers, an apprenticeship. They begin by sneezing; then the mucous membrane of the nasal fossæ becomes accustomed to the drug, is palled, and even finds itself pleasantly tickled by the ammoniacal piquancy and nicotian perfume of the virulent powder. At last it becomes thick, and with intemperate snuff-takers perceives odors only feebly. It becomes sometimes the seat of a chronic inflammation which extends to the pharynx and produces a slight dry and characteristic cough. Snuff-takers are told of who have suffered from eruptions, ulcerations, and polypi; others have become deaf; but such cases are so rare and their etiology is so doubtful that serious account need not be taken of them.

The only phenomenon peculiar to nicotine often observed among snuff-takers is a rhythmic trembling of the hands, not like that of old men or that of drunkards, but which is observed likewise in excessive smokers. A single case is mentioned by Dr. Bean of *angina pectoris* in a patient who was addicted to an excessive use of snuff. But a solitary case is not important in the consideration of a habit so general, and there is no need of pursuing a fugitive enemy. Snuff-taking is condemned by fashion, from whose decrees there is no appeal. Those of hygiene are not so imperative.

Smoking is charged by its opponents with injuring the health and debasing the mind. The former part of the charge has a measure of foundation. There is certainly nothing hygienic in the habit. All are acquainted with the troubles that ensue on the first effort to smoke. There are nauseas, soon followed by vomiting, headache, vertigo, and a condition resembling sea-sickness, and much like the earlier phenomena of acute poisoning by tobacco. These troubles soon pass away, and after a few succeeding efforts the smoker accustoms himself to the action of the smoke. When the habit is once acquired, smokers feel no further incon-

venience; and there are some who are able to smoke just before sitting down at the table. Smoking generally dulls the appetite and gives relief against the pains of hunger. But after eating the desire to smoke becomes irresistible. This is the psychological moment; and the pleasure we feel then is more intense than at any other time in the day. The pipe or the cigar is a condition of good digestion for some smokers, but in others it produces gastric troubles. Nervous people, those who lead a too sedentary life, and office men, especially if they have the habit of smoking before meals, gradually lose their appetite, and acquire instead of it a painful anxiety and nausea. Others suffer from pyrosis. There are smokers who can not light a cigar at some hours in the day without having the feeling of hot iron that marks that affection. Nearly all excessive smokers are dyspeptics; and the fact is explained by the excess of salivation and the diminution of the gastric juice and of the functional energy of the stomach. Next after the digestive troubles, the most common affections touch the respiratory organs and the heart. Granular pharyngitis is very common among persons who smoke to excess. The irritation of the pharynx is often communicated to the larynx, and there results a peculiar dry cough. Others feel a temporary oppression in the evening after having smoked during the day. A special form of asthma has been mentioned as caused by the abuse of tobacco; but cases of it must be very rare, for I have never observed it, though I have passed my life among smokers. Affections of the heart are more frequent. Some doctors assert that one fourth of the smokers are afflicted with palpitations and irregularities of the pulse. I do not know where such observations have been made, but I have never seen any cases of the kind. I, as well as other doctors, have met cases of *angina pectoris*, chiefly among persons who passed their lives in an atmosphere saturated with tobacco, and among those who have swallowed the smoke of their cigars, and have not been surprised at them, because the smoke then enters into the lesser ramifications of the bronchial vessels, where it impresses directly the finest nervous threads of the lungs and the heart, and its action induces the spasms of suffocation that constitute that terrible disease. These symptoms are at first fleeting, and rarely mortal; but, if the patient does not abandon his habit, they occur more frequently, and become more grave till death ensues in one of them. Disasters from breathing an atmosphere saturated with tobacco-smoke seem more liable to occur with children than with grown persons. Staying in smoking-rooms, where the smoke is sometimes so thick that one can hardly see from one end of the room to the other, is dangerous to persons subject to palpitations, even though they do not smoke. Dr. Vallin has cited three facts conclusive as to this point, one of which re-

lates to the case of a young officer who had given up tobacco three months before, and was attacked with a suffocation like *angina pectoris* after having passed several nights in his room where his friends came to smoke for some hours every evening. Dr. Gélineau tells of an epidemic of *angina pectoris* among some sailors who were crowded in the between-decks of a merchant vessel during a storm that made it necessary to close all the hatches, and who smoked to pass away the time. Those who did not join in the smoking suffered equally with the others, for they breathed the same toxic atmosphere.

Pipe-smokers are in danger of epithelioma, or cancer of the lips and of the tongue. The former occurs chiefly among persons who smoke a very short-stemmed clay pipe. Smokers' cancer appears usually at the point where the hot pipe-stem bears upon the lower lip, and on the side of the tongue at the point where the smoke touches at each aspiration. In some cases it begins with buccal *psoriasis*, a kind of thickening of the epithelium of the tongue, which becomes white, glossy, and horny. These two forms of a horrible malady are incontestably the most serious danger smokers incur; and the fear of it is the motive that has impelled the majority of conversions from the habit. The frequency of them should not, however, be exaggerated.

Tobacco has been accused of contributing to the depopulation of the country by enfeebling the reproductive powers of men and inducing miscarriages in women. The former part of the charge is founded on the very real fact that the smoking of tobacco, while its influence prevails, appeases all ardor; but its action is essentially temporary, and does not detract from the general powers of smokers. Their families are as numerous as those of other persons, and the peoples who smoke most are precisely those who have the most children. The Germans smoke twice as much as the French, and have five times as many children. The possibility of tobacco promoting abortions is more open to discussion, but it can not exert any noticeable influence on the movement of population, for it concerns only a very limited class of women—those who work in tobacco-factories. These establishments have borne a bad reputation in the past, and the effect of life in them upon the operatives has been painted in very dark colors. All manufactories were until recently in a deplorable hygienic condition. Now the rooms are spacious and well ventilated, and all precautions are taken to preserve the health of the operatives.

But, whatever may be done, the vapors of nicotine can not be got rid of in the shops where large quantities of tobacco are dried and fermented, or where it is stored in bales and casks. When the leaves are cleaned and mixed, in rasping and grinding, dust as

active as the vapors is diffused around. Operatives who work in this atmosphere are in the situation of smokers, and become habituated to it after having suffered the same disorders in the beginning. Those who work in smaller and insufficiently ventilated rooms are often more seriously affected; but, as a rule, these workmen enjoy good health. Opinions as to the particular effect of this employment on women differ; but the prevalent result of the discussion appears to be that tobacco does not provoke abortion, and has no mischievous influence on the health of women operatives. Abortion is not more frequent among them than among other working-women; and the weakness and mortality of their children are easily explained by the fact of their being left at home while their mothers are at the shop.

Among the maladies to which hardened smokers are exposed is nicotinic amblyopia, which Sichel noticed first, and which has been well studied by modern ophthalmologists. It is a peculiar weakening of the sight, and is distinguished from other affections of the kind by the readiness with which it passes away when the patient gives up tobacco, and the promptitude with which it appears again when he resumes the practice. It is very rare. So is a paralysis which has been observed in Germany. Delirium tremens, convulsions, epilepsy, hallucinations, dementia, precocious senility, and melancholia have been mentioned as among the evils brought on by tobacco. No doubt smokers have them, and many other diseases. Tobacco will not save them from any of the ills with which mankind is afflicted.

Of all the accusations that have been made against tobacco, that of blunting the intellect is the most cruel to smokers. But the evidence in favor of it is not formidable. That most frequently encountered is obtained from statistics that show that in institutions for public instruction smokers stand lower in their classes than other pupils. Decaisne has shown this for the French lycées; MM. Bartillon, G. Doré, and Élie Joubert, for the pupils of the Polytechnic School; and Dr. Coustan, for the Normal and Naval Schools and the School of Bridges and Roads. The demonstration is hardly satisfactory. It seems reasonable to assume that the smoking pupils do not succeed so well as the others because they are idle and find in tobacco an auxiliary to their indolence and a relief from its consequent *ennui*. Probably, if the investigation had been pushed further, it would have been found that the same pupils are those whose general conduct leaves most to be desired, and who are most frequently punished. Discussion of this charge brings up an international comparison that is not favorable to its validity. There is a people north of the Rhine, whom I have already mentioned, and with whom the use of tobacco has almost become an institution. They consume a half

more than we (the French), and yet we have to admit that these Germans are not as dull as they should be by the theory, that they do not cut a bad figure in the scientific world, and that they hold a preponderant position in Europe. A more specious argument than this is one which the detractors of tobacco draw from the enfeeblement of memory which many observers pretend to have remarked. This would be a serious matter if the charge was sustained; but it does not appear to me proved. Instances have been related in good faith, it is true, of persons who are supposed to have lost their memories through the use of tobacco; but my impression is, that the loss can be more properly attributed to advancing age.

I have no thought of writing an apology for tobacco, or of asking for the erection of a statue of Jean Nicot. Smoking is a bad habit for everybody, especially for women and children. But because tobacco is a grand culprit is a reason why it should not be painted blacker than it is. If we exaggerate its faults and attribute imaginary ones to it, we run the risk of wholly missing our aim. In fact, children whom we are trying to preserve from it, when they see smokers around them able-bodied and sparkling with wit, are disposed to think we are deceiving them when we hold up this bugbear before them, and will come to not believing the real evils of the bad habit against which we are trying to fortify them.

Last to be considered is the philosophical side of the question: What is the motive that impels so many persons to contract an inconvenient, expensive, and unhealthy habit? The problem is insoluble to persons who do not smoke. "I can never comprehend," lately said a professor of hygiene, "the enjoyment one can feel in converting his mouth into a chimney-flue." Dupuytren called the habit of smoking the ignoble pleasure of poisoning one's self and others. This is not surprising; but it is more so that smokers themselves can not account for the fact. The general opinion is, that we begin to smoke to imitate others, and continue it by habit, as a distraction, or means of dispelling *ennui*. "The boy of fourteen or fifteen years, beginning to smoke," says M. Dumas, "does not seek a cerebral excitement in the new habit any more than one who is beginning to drink. He simply imitates the bearded persons whom he sees with the pipe or cigar in their mouths. It is to him one of the signs of the virility to which he aspires. It is the easiest way for him to make himself believe that he is already a man, and to make the public believe it." This is true, but few smokers can find any traces of this feeling in their recollections; but while the desire of affirming one's virility and doing like others may explain the first essays in the face of the pains that attend them, it does not account for the irresistible attraction of the habit once formed and the readiness with which it establishes itself.

The customs and tastes of populations and the fashions change and give place to others that disappear in their turn, after having inspired the same infatuation in us; but the habit of smoking goes on increasing, over all obstacles. The earliest adepts of the practice braved anathemas and persecutions, and some of them punishments. The smokers of to-day do not have to make the same struggles, but many of them endure troubles that compromise their health rather than abandon the practice, and among these are men of energy and intelligence, whatever else may be said of them.

There must, therefore, be in this passion something besides the satisfaction of a mechanical habit. "The particular intoxication caused by tobacco," says M. Dumas, "must have irresistible attractions for an intoxicant of so recent discovery, the initiation into which is so painful, to have overtaken wine, old as the world." The charm of tobacco-intoxication is not easy to explain. It is in the soothing, says M. Fay; it is an anæsthesia that has become necessary, says M. Richet; it is a state of torpor which conduces to revelry, say others. Tolstoi maintains that it is nothing of this kind, but the desire to stifle the voice of conscience; and, confounding tobacco with alcohol and opium, the Russian romancist envelops them both in the same anathema. In explanation of his view he has recourse to a theory known in physiology as that of duality, or human dynamism. During his conscious life, Tolstoi says, man has frequent occasion to recognize in himself two distinct beings: one blind and sensitive, the other enlightened and thinking. The former eats, drinks, rests, sleeps, reproduces, and moves, like a machine wound up for a certain time. The other, the thinking and enlightened, united with the sensitive one, does not act by itself, but only controls and appraises the conduct of the former one, helping it effectively if it approves, and remaining neutral in the contrary case. This spiritual but powerless being plays in human psychology the part of the compass of the ship, of which the other being is the helmsman. The last can follow the directions of the magnetic needle, or he can pay no attention to them; he is even able, when its warnings annoy him, to disarrange his compass. Weak and timorous persons have recourse to the last expedient. They stifle their conscience, and, in order to do so, use alcohol or tobacco.

Count Tolstoi's theory can not be sustained. It has one particularly weak point in the similarity which the author assumes between the effects of tobacco and of alcohol. Not one of the personages whom the translator of his work consulted protested against this confusion, and still it is false and deceitful. The Russian's paradox may be applied, to a certain extent, to drunkenness. We do sometimes get drunk to forget, to stupefy ourselves, and it is a detestable means. Rogues and criminals all do it; they

drink often to give themselves heart, murderers especially; while there is not a case known, as M. Aurelian Schole has observed, of a crime committed with pipe or cigar in the mouth. The author himself confesses that he dulled his conscience with tobacco for a long time. It had not, it is true, many reproaches to address to him. Sometimes it reproved him for idleness, or admonished him for a neglect, or a want of punctuality, or an excess of passion in which he had not measured his tone. To quench his remorse he lighted a cigar, and all was forgotten. If tobacco had never committed worse misdeeds, nobody, I believe, would have thought of quarreling with it.

Other modes of voluntary intoxication have the common characteristic of deranging the reason and the moral sense. Hashish produces hallucinations and delirium, and plunges persons into a condition like madness. Opium puts to sleep, and procures for some persons agreeable dreams; but one becomes quickly habituated to it, the doses have to be increased, all the functions flag, and the opium-smoker falls into a condition of inanity, at times interrupted by fits of homicidal furor. Morphinomaniacs do not suffer the same perversion of mind, but they become false, dissimulating, indifferent to all that is foreign to their passion, extending to family feeling and even to honor. Their health is injured more quickly than by opium-smoking, and their life is shortened as much. Alcoholism is still worse. I have studied its effects in all their phases in another work, and will not repeat my conclusions now. It is sufficient to recollect that the ignoble and degrading vice attacks nations in all their vital forces; families in their honor, fortune, and prosperity; that it peoples hospitals, insane asylums, and prisons; and costs France a milliard and a half of francs a year.

Tobacco can be reproached with no such mischief. It has never led the reason astray, destroyed the will, or perverted the sensibility of any one. The most hardened smoker enjoys at all times the most perfect clearness of mind. Even at the moment when he is under the influence of nicotine he talks, reasons, studies, and works with a freedom of thought that proves that his intelligence has not received any harm. One might say that tobacco had disengaged him from physical impressions, and that, as Dr. Richet says, it mollifies the sensibility of the organs only to leave the psychical functions greater freedom of evolution.

There is another characteristic difference between tobacco and other voluntary poisons. A person can break up the habit of using tobacco, while alcoholism and morphinomania are almost incurable. At the end of my long career I can not recollect having witnessed more than two or three cures from alcoholism, and I can not affirm that they would have been permanent if the sub-

jects had been exposed to new temptations. Morphinomaniacs are absolutely incurable unless they are interned. Smokers, on the other hand, can correct themselves when they wish to. They only need a firm will. We see persons every day who have done this; and since the troubles caused by tobacco have been more definitely known we see many men giving it up of their own accord as they advance in age. The habit is so completely lost that after a few years the reformed victim can find himself in a company of smokers without feeling a desire to imitate them; and if he is moved to light a cigar he will not find the pleasure of the old days in it.*

I might stop here; but I will not finish this article without giving my own explanation of the fascination of tobacco. It is probably no better than the others, and I will not try to impose it on any one.

Men have at all times eagerly sought for substances that would act on their nervous system. The tendency is general, and is exclusively human. To escape real life and the drudgery of daily occupations, to live in dream-land, in an ideal world which the imagination can people at its will, and can embellish with its illusions, have irresistible charms to some minds. In obedience to this dangerous seduction they involuntarily seek the dreams of opium and hashish, the intoxication of ether and chloral, or the grosser drunkenness of alcohol. The weak yield unresistingly to their inclination, and pass into the degrading excesses which I have reviewed. Tobacco offers no such seductions and is attended with no such dangers. Its action on the nervous system is weak and wholly special. It does not put to sleep, but it calms and mollifies the sensibility of the organs. It causes an agreeable torpor, during which thought continues lucid, and the capacity for work is not diminished. Such is the attraction it exercises, and which causes it to be sought for by so many thinkers and students. Tobacco is to them a help in mental labor. When fatigue begins and the need of a moment's rest is felt; when the thought fails to present itself with the usual exactness, and the mind hesitates over the shape to give it, the student, writer, or investigator stops, lights his pipe, and soon, by favor of this pleasant narcotic, the thought appears clear and limpid through the bluish cloud in which the smoker has enveloped himself.

I should make a wrong impression if I left it to be believed that I thought tobacco necessary to mental labor. It becomes so only for those who have contracted the habit of using it, and they

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* The translator of this article was an inveterate smoker till the summer of 1868. One evening he said to himself that he would not smoke that evening. That is all the resolution he ever took; but he has never smoked or desired to smoke since.

can divorce themselves from it without losing their capacity. As a whole, tobacco is harmless to the mind, but it may have a mischievous influence on the health, and may cause serious diseases. We should not advise any one to use it, and should try to keep women and children from doing so. In taking up this part of its programme, and in affiliating itself with teachers of all grades, the Society against the Abuse of Tobacco has performed real service; but it has tried to gain its end by exaggerations that can only compromise it. It is of no use, and would be labor lost, to try to convert adult smokers so long as they experience no inconvenience from the habit. As soon as they begin to feel some troubles, and have reached an age when the troubles may become grave, the dangers to which they are exposing themselves should be described to them without extenuating them, but without making the picture blacker. If dangerous affections are threatened, like *angina pectoris*, or injuries to the tongue and lips, a decisive course must be taken, and the immediate and complete abandonment of the cigarette and pipe insisted upon, for experience has taught that there can be no gradual leaving off.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

## ODORS AND THE SENSE OF SMELL.

By M. CHARLES HENRY.

A CONSIDERABLE number of mineral compounds are odorous. It is enough to mention, as illustrations of the fact, the sulphureted hydrogen odor of rotten eggs, and the scent of hydrocyanic acid which emanates from bitter almonds. Although perfumes, or pleasant smells, are organic or carbon compounds, the distinction between organic and inorganic may be considered artificial, since the principal organic bodies can be obtained by the combination of such simple mineral elements as carbon, oxygen, hydrogen, and nitrogen. On the gradual complication of syntheses of this kind M. Berthelot, who has made more of them than any other chemist, has based a classification of organic compounds into eight categories. We have first, hydrocarbons, formed of the two elements—acetylene, formene, benzene, turpentine, styrolene, etc. The bodies composed of three elements—carbon, hydrogen, and oxygen—are divided among four categories. We distinguish between the alcohols, which are capable of uniting directly with acids to form ethers with the elimination of the elements of water; the aldehydes, which are formed at the expense of the alcohols, with the loss of hydrogen, among which are the essence of bitter almonds and the essence of cinnamon; the acids, like

acetic and benzoic acids, which can unite with bases and form salts; and the ethers, the results of the association of alcohols, acids, or other alcohols, among which are the oils of the onion and of mustard. Among quaternary compounds we have the alkaloids formed by the union of the alcohols with ammonia or other alkalies, amides formed by the union of ammonia and acids with the separation of the elements of water; and the metallic radical compounds which are obtained by the reaction of metals on some of the ethers.

Perfumes are, in general, binary or ternary compounds characterized by the fact that the proportion of equivalents of hydrogen to those of carbon diminishes at the same rate as those of another class of products very rich in hydrogen which are called the fatty series, while this class of products, less rich in hydrogen, is called the aromatic series. Is there any relation between odor and chemical composition? An English physiologist, Mr. John Berry Haycraft, in his studies of the savors and odors, and savors of the principal compounds of each natural family of bodies, particularly of compounds of the family oxygen, sulphur, chromium, selenium, molybdenum, tellurium, didymium, tungsten, and uranium, has observed modifications in odor corresponding with increase in atomic weights. For example, sulphureted hydrogen, hydrogen selenide, and hydrogen telluride smell like rotten eggs. The compounds of elements of this family with methyl and ethyl have an alliaceous odor. So with the family chlorine, bromine, and iodine; the acids which these bodies form with hydrogen and their compounds with methyl, ethyl, and ethylene have similar odors, so that some among them seem to share them with their neighbors; bromoform, for example, having a similar odor with chloroform and iodoform. Passing to the organic series, Mr. Haycraft observes in the monatomic alcohols a modification of odor corresponding with variations in atomic weight. Methyl alcohol, for instance, has a weak odor of alcohol; ethyl alcohol has the typical alcoholic odor; propylic alcohol has both an alcoholic odor and a special smell; isobutylic, amylic, and octylic alcohols progressively lose the alcoholic odor and acquire as against it a special scent. The same facts are remarked in the fatty acids and hydrocarbons.

Similar odors may be furnished by bodies without likeness in chemical composition. Arsenic in oxidizing disengages vapors that have the odor of garlic. Nitrobenzene, benzoic aldehyde, and prussic acid smell much alike. It has been asserted that emeralds pounded and ground several hours a day for three weeks had emitted a well-defined odor of violets. The fact has been verified; but it has yet to be determined whether it is due to the manipulation or to organic substances that have been released by

the trituration. Sulphuric acid, combined with distilled water, disengages a pungent odor resembling that of musk. The odor of musk is brought out in a great many reactions. The nitrate derivatives of aromatic substances smell of it; artificial musk and natural musk have no chemical resemblance. So alcohols chemically identical, but of different derivation, do not behave alike with essential oils. As odor is thus in a great measure independent of the chemical constitution, it must depend upon the disposition of the particles, a property which it is evidently impossible to discover by any known chemical processes.

A few eminent chemists, following Dalton, Avogadro, and Ampère, have tried to make up for this impossibility by hypothesis, and have taken up the great problem of predicting and explaining chemical combinations and isomeries. Their theories, called atomic, have been adopted in most of the original memoirs and taught in most of the text-books. Whatever may be their scientific value, the aids they give him in retaining and recollecting the formulas present incontestable advantages to the student. The applications of them to the study of the aromatic series are famous.

The radical of the hydrocarbons of this series and of all the other compounds is benzene, a body composed of six atoms of carbon and six atoms of hydrogen; when it is attacked by a reagent, and we substitute for an atom of hydrogen another simple body or a group of atoms, whichever of the atoms of hydrogen the substitution may bear upon, we obtain a single product; whence it is concluded that each atom of carbon is united to an atom of hydrogen, and that a symmetrical exchange can take place of the atoms of carbon among their valencies. A German chemist, Herr Kekulé, has tried to express these peculiarities by a hexagonal scheme which has still some lack of symmetry, and M. Ladenbourg has substituted a prismatic scheme for it. In this figure the six atoms of carbon of the benzene occupy the summits of a triangular prism, each one being united with an atom of hydrogen and exchanging the three valencies that are left it with the three next atoms of carbon by the three edges which meet at the summit. The perfect symmetry of this scheme is well expressed in the simple construction of the figure. But usually, for greater convenience, the hexagonal construction is adopted, and the reciprocal relations of the atoms of carbon and hydrogen are represented by figures in which the more or less complex lateral chains are joined, and which offer the remarkable characteristic of being closed chains—that is, of always returning to their starting-point. What the atomic theories have taught us concerning odor is limited to this singular and so far unfruitful representation; it is evident that they are still mute concerning the real structure of

the molecular edifice. The efforts which have been recently made to fill this void are more difficult to expound and follow than fruitful in applications.

Six methods of extracting perfumes are known: The first is expression, by means of a special press, which is applicable without too great loss to fruit-skins rich in essential oils, such as orange and citron peel, previously grated. Another method is that of distillation, which consists in heating flowers with water in a boiler. The essential oil is volatilized and is condensed with the vapor of water in a worm and a Florentine receiver. The water usually goes to the bottom and the oil floats. The oils of neroli, rose, patchouli, geranium, lavender, caraway, etc., are obtained in this way. This process is not applicable to the delicate perfumes of the mignonette and the violet; and for them recourse is had to maceration of the flowers in animal fats or mineral oils, which have the property of absorbing odorous substances, and are then washed in alcohol. The flowers are usually heated in the fat or the oil for a variable number of hours. For perfumes which can not endure a high temperature the petals are placed between two frames of glass coated with fat. This is the process of *enfleurage*. The pneumatic process, which consists in causing a current of perfumed air or carbonic acid to be absorbed by coatings of lard on glass plates, appears not to have given satisfactory results. Another process consists in dissolving perfumes in very volatile liquids like sulphuret of carbon, chloroform, naphtha, ether, or chloride of methyl, and volatilizing the solvents, which can be done at a low temperature in a vacuum. The last method has given very satisfactory results in the extreme delicacy and great accuracy of its returns.

| Series. | Types. | Secondary odors of the same series. |
|---|---|---|
| Rose | The rose | Geranium, eglantine, palissander. |
| Jasmin | The jasmin | Lily of the valley, ylang-ylang. |
| Orange | Orange flower, or neroli | Acacia, syringa, orange leaf. |
| Tuberose | Tuberose | Lily, jonquil, narcissus, hyacinth. |
| Violaceous | Violet | Cassis, iris, mignonette. |
| Balsamic | Vanilla | Balsams of Peru and Tolu, benzoin, storax, tonka bean, heliotrope. |
| Spicy | Cinnamon | Nutmeg, mace, allspice. |
| Caryophyllaceous | Clove | Pink. |
| Camphor | Camphor | Rosemary, patchouli. |
| Sandal | Sandal-wood | Vetivert, cedar. |
| Citrine | Citron | Orange, bergamot, cedrat, lime fruit. |
| Herbaceous | Lavender | Aspic, thyme, wild thyme, marjoram. |
| Mint | Peppermint | Wild mint, basil, sage. |
| Anise | Anise | Anise-seed, caraway, dill, fennel, coriander. |
| Almond | Bitter almonds | Laurel, nut, mirbane. |
| Musky | Musk | Civet, musk-mallows. |
| Amber | Ambergris. | |
| Fruit | Pear | Apple, pineapple, quince. |

Numerous classifications of odors have been proposed. It is, of course, impossible to quote any rational classification. The natural way is to group around a type, in successive series, odors which resemble one another. Eugène Rimmer has tried to do this in the accompanying table.

The author observes that it would be hard to arrange in any of these series certain peculiar odors like that of wintergreen, or salicylate of methyl and magnolia. Notwithstanding the uncertainties attending the arrangement, we must apparently depend upon classifications based upon this principle for a guide in the study of odors.

All that we know concerning the propagation of an odor is that it consists in an emission of solid, liquid, or gaseous particles. This emission is allied for these three states of matter to the property called diffusion, which consists in the reciprocal penetration at the end of a certain time of the particles of two or more bodies among one another; and also for solids and liquids to the property called volatility, or the rapidity of evaporation.

But little is known concerning the diffusion of solids. If we heat to a high temperature a porcelain crucible within a crucible of plumbago, the plumbago will penetrate the porcelain to a depth varying according to the duration of the experiment. M. Pellat has shown, by delicate measures of quantities of electricity, that metallic surfaces placed parallel to one another a few tenths of a millimetre apart, reciprocally exchange their outer surfaces, as if they emitted a little of their own substance to each other. When the influence ceases, the surfaces gradually lose their foreign coatings, and return slowly to their primary condition.

The diffusion of liquids is easily observed. It can be witnessed by introducing, with a pipette, into a vessel under water a colored liquid, red wine, for example. The wine, being lighter than water, rises to the surface, and does not color the deeper layers of the water till after one or two days. There is doubtless in the complicated diffusion of liquids a kind of chemical action related to the movements on water of camphor and a considerable number of diffusible substances. If we put a bit of camphor on the surface of water, it at once turns round and moves in every direction. If a drop of oil is let fall on the same surface, the movements will cease immediately. The motion arises from the diffusion of camphor in a liquid form on the surface of water. When, after the surface is saturated, there is no more diffusion, the motions cease. They also cease when two currents are produced by different bodies in opposite directions. That there is a liquid diffusion is proved by the fact that when the camphor is placed on a float of pith, or on the polished surface of mercury, there is no movement. So, if a bit of camphor is put into a large

saucer covered with a thin layer of water, the water immediately retires, sometimes for several centimetres, before the odorous substance. The laws of the diffusion of liquids may be summarized by saying that the rapidity depends on the nature of the substance, increases in proportion to the degree of concentration of the solution, and augments as the temperature rises. Graham's dialyzer is based on the very feeble diffusibility of certain substances, like the gums, and the great diffusibility of certain crystalline substances, like salt. It is simply a vessel, the bottom of which is formed of a leaf of parchment paper, that lets the diffusible substances pass into the water around it and holds the others.

The diffusion of gases and vapors, which is more important in questions of smell, is subject to laws which have been only approximately determined. A glass tube about a metre long is used, divided perpendicularly to its length by a thin metallic partition, which can be made to slide between two perforated glasses. A gas is introduced into each of the separated halves of the tube; the supply-cocks are closed, the partition is lifted out, and the two halves of the tube are put in communication; a half-hour later the partition is shut, and the gaseous mixture contained in each of the compartments is analyzed. Mr. Loschmidt has in this way found the mathematical rule for the measure of the diffusion of different gases, one within the other.

The volatility of a liquid is expressed by the weight of that liquid which evaporates per second and per square millimetre at a given temperature. All that is known of it is that this weight is proportioned to the excess of the maximum tension of the vapor at that temperature over the tension which it has in the air; and this weight varies inversely as the atmospheric pressure according to a law special for each liquid. Evaporation may, therefore, give us valuable information concerning the purity of the odor, and spare us, in many cases, the delicate problem of determining the maximum tension which is so important a characteristic of substances. A special apparatus has been devised for the rapid measurement of volatility.

Tables have been prepared showing the relative volatility of different perfumes, of the substances used for adulterating them, and of the adulterations, by means of which a convenient method is afforded for the detection of frauds.

The influence of different physical forces on the disengagement of odor has been studied; and possible relations between the colors of flowers and the intensity of their perfumes have been inquired into. It has been found that white flowers represent the largest number of odoriferous species, and after them come red, yellow, green, and blue. The order corresponds with that of the

emission of calorific force. Flowers which by their color emit the most heat, also emit the most perfume.

The results of the study of the influence of the color of substances on their power of absorbing odors differ a little from these: white, yellow, red, green, and blue absorb odors in a decreasing order, or rather emit them in an increasing one. These colors represent decreasing luminous powers.

Ozone develops the energy of essential oils, and perfumes in turn determine by their oxidation in the air the production of ozone. This is a matter of hygienic significance, for the presence of ozone being favorable to health, we have a means at hand of increasing the supply of it by surrounding ourselves with fragrant substances and flowers.

Heat favors the volatilization of perfumes, and to such an extent that beds of flowers are sometimes inodorous in the bright sunlight which are fragrant in the shade. Some essences need a high temperature for the production of their full effect; while others, to have their delicacy fully appreciated, require the coolness of the evening. This principle may account for apparent differences of tastes among the people of different countries. The odors of many substances are not of equal strength in different climates. Prof. Tyndall believes that there are considerable differences in the absorbing power of different odorous vapors for radiant heat. He perfumed small paper cylinders by dipping them by one end in an aromatic oil, and then placed them in a glass tube, which communicated, through a stop-cock, with a tube in which a vacuum is produced. The air, according as it has been perfumed with one substance or another, discloses to the galvanometer an absorbing power, which, air at the usual pressure being taken as one, varies from thirty for patchouli, to three hundred and seventy-two for anise-seed. These results are, unfortunately, not exact, for no account is taken in them of the tensions of the odorous vapors, which certainly vary, though they are probably of very small absolute value.

Messrs. Nichols and Bailey have compared the smelling powers of men and women. Having made measured solutions of a number of essential oils, a series of flasks was prepared so that the solution in each succeeding one should be only half as strong as that in the preceding one. The flasks were "shuffled," and the subjects of the experiment were called upon to rearrange them in the order of concentration of the solutions. The smelling power of women appeared to be on the whole less delicate than that of the men. The extreme delicacy of the scent of the dog is well known. Mr. Romanes has shown that, by fastening a sheet of paper to the shoes, the odor may be masked, and the dog prevented from following the track of his master; but that a contact with the

ground of a few square millimetres is enough to enable the dog to follow the scent. In birds, the sense of smell appears to be little developed; in mollusks and insects the smelling apparatus has been located in the antennæ. Below the group of worms, no olfactory reactions have been, so far as I know, definitely established.

The mechanism of the olfactory apparatus is, as a whole, simpler than that of sight and hearing; but the sensation is subordinated to many individual anatomical peculiarities. As much can be said of touch and taste, which require contact of the excitant, while sight and hearing merely register the vibrations transmitted by a medium. It is easy to conceive how the condition of the membranes, the form of the nasal passages, etc., may affect the sensation.

A distinction is made in medicine between respiratory anosmias which depend on the formation of the organs and the condition of the connective tissues, and essential anosmias which result from atrophy of the nerves. Anosmias are frequent; some are congenital, many are senile and temporary, and connected with traumatisms, hemianæsthesia, aphasia, and hemiplegia. We can not expect to find as concordant reactions for the smell as for the sense of color or the sense of form. It is nevertheless a matter of interest to investigate, on as good subjects as we can get, the influence of different odors on sensibility; or, in other words, to determine the weight of odorous vapor which it is necessary to breathe and accumulate in the nasal fossæ to make a perfume perceptible. That is the purpose of olfactometers. The olfactometer gives, besides this, the intensity of a perfume. The larger the perceptible minimum of a perfume, the less intense the perfume is, and it is this intensity which determines the price of a perfume, the delicacy of its odor being the same.

The olfactory sense is followed by effects of different kinds of intensity from those of sight and hearing, and may be accompanied by a kind of poisoning. The old medical books are full of stories of it. There are those of a girl killed by the exhalations of violets; of a woman seized with a violent headache from sleeping on a bed of roses; and of a girl who lost her voice by smelling of a bouquet. Ancient medicine attributed curative properties to perfumes, particularly to those of the rose, musk, and benzoin. The intensity of the effects of perfumes makes a rapid succession of sensations almost impossible; for consecutive odors cause a rapid anæsthesia of the sense; on the other hand, if the times separating two successive sensations are too long, it becomes impossible to combine them, and the anticipated effect is disturbed by strange feelings. In short, smell is rather the complement of other excitations than an artistic excitation like

a melody or a picture. Its function is, nevertheless, very important. By virtue of its volatility it is a valuable prophylactic; by the great intensity of its effects it can bring about salutary modifications of physiological functions, particularly of the amplitude of respiration; and it possesses in the highest degree the luxurious character of every artistic enjoyment. Flavor has an essential part in nutrition; so has touch. Hearing and sight are indispensable to relations with other persons; but smell, necessary to the animal for finding its prey and avoiding danger, has become, under normal conditions, an almost useless sense to man, since the refinements of civilization tend to prevent the production of miasms and the pestilential odors from which he has to protect himself. It is therefore becoming more and more a sense of luxury for civilized man; and that, perhaps, is the reason why poets, from the author of the Song of Songs down, have associated all kinds of beauty and joy with perfumes.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

## CHANGES IN CHEMICAL AND GEOGRAPHICAL WORDS.

By FREDERIK A. FERNALD.

"HOW do you pronounce *quinine?*" is a question that is often asked, and, unless the person appealed to is unusually dogmatic, the answer is never decisive. Webster's International Dictionary gives three forms as being in good use—namely, *kwī'nīn, kwĭ'nīn,* and *kwĭ'nēn;* the Century Dictionary gives two of these and a fourth form, *kwĭn'ēn, kĭnēn',* and *kwī'nĭn;* while a fifth variant is found in Stormonth, which has only *kwĭn'ĭn* and *kwĭnīn'.* Physicians and chemists, from having to use this word oftener than the general public, have been more annoyed by the conflicting pronunciations. Other words that have troubled the chemists are the names of the halogens, some pronouncing them *chlō'rĭn, brō'mĭn, ī'ōdĭn,* and *flū'ōrĭn,* while others said *chlō'rēn,* etc. A more serious difficulty is the liability to mistake certain substances for others, from the close likeness of whole classes of names, both when spoken and when written. This occurs with the *chlorīdes* and the *chlorītes,* also with the *sulphīdes* and the *sulphītes.* In order to do away with these difficulties, a proposition for a revision of the spelling and pronunciation of chemical terms was made in the Chemical Section of the American Association for the Advancement of Science, at the annual meeting in 1887. Accordingly, a committee to make

such a revision was appointed, and made its final report at the meeting of 1891. This report says:

During the past four years, your committee has sought to obtain from the members of this section, from leading American philologists, and from American chemists in general, an exhaustive and thoroughly representative expression of opinion on the questions coming within the scope of its commission, which has been essentially the attainment of uniformity in the orthography and pronunciation of the terms used in our science.

Three preliminary reports were distributed to American chemists in the years 1889, 1890, and 1891, inviting extended criticism and suggestion. The substance of the replies to these was carefully digested and submitted to the Chemical Section each year for detailed discussion and decision. The present and final report of your committee embodies the results of these four years of correspondence and discussion, as completed by the sectional action at the present meeting of the Association. It is presented in the hope that all chemists, especially those engaged in teaching, will cordially unite in the effort to bring about the desired uniformity in usage.

The reasons for the adoption of a few more radical changes in our nomenclature are to be found in the report for 1890. Those specially interested in the subject who have not attended the recent sessions of the Association may freely correspond with individual members of the committee, who will gladly furnish more detailed explanation of the principles involved.

The following summary of rules is not to be regarded as final. Your committee recognize the fact that, after a fair trial for a decade or even less, certain modifications will in all probability be generally regarded as desirable.

In conclusion, the committee express their sincere thanks to their many colleagues throughout the land, who have so promptly and fully responded to the successive requests for data, suggestions, and opinions.

(Signed) T. H. Norton,
Edward Hart,
H. Carrington Bolton,
James Lewis Howe.

Among the decisions of the committee (all being accepted by the Chemical Section) is to sound the *i* short in the names of the halogens, and the spelling is changed by dropping the final *e*, so as better to indicate this pronunciation: thus, *chlorin, bromin,* etc. The "pentalemma" of *quinine* is conquered by adopting a sixth pronunciation *kwī'nĭn* and the final *e* is dropped, making the spelling *quinin.* Similar treatment is accorded to *anilin, morphin, glycerin, cocain,* etc. The similarity between *-ide* and *-ite* is removed by changing the former to *-īd,* giving *chlorid, bromid, oxid,* etc.

Polysyllables in the metric system are regarded as compound words, each part with its own accent; thus, not *centi'meter,* but *cen'time'ter.* The spellings *aluminum* and *asbestos* displace *aluminium* and *asbestus; gramme* is preferred to *gram* (probably to avoid confusion with *grain* in indistinct handwriting); *al'kalīne* retains the long *i* and its final *e*; *al'loy,* both as noun and as verb,

is accented on the first syllable; and *apparā'tus* does duty in both the singular and the plural numbers. *Quan'tiva"lence, ū'niva"lent,* etc., have both a primary and a secondary accent, as has *no'mencla"ture.* A few more preferred pronunciations are *con'centra"ted, mŏl'ecule, mŏlĕc'ular,* and *ăldehīde*; both *crystallĭn* and *crystallīne* are accepted. Probably the boldest change in spelling is the substitution of *f* for *ph* in *sulfur* and all its derivatives. *Phosphorus,* however, remains unchanged.

Where two or more names are in use for the same thing, the chemists have given a preference to one of them. Thus, they advise the use of *caffein* rather than *thein, hydrogen sulfid* rather than *sulfuretted hydrogen, valence* rather than *quantivalence,* and *univalent, bivalent,* etc., rather than *monovalent, divalent,* etc.

A large number of other decisions have been rendered, but the foregoing are all that affect words that are in general use, or much used by teachers. The changes which the chemists have decided on are far from being radical. They are all plainly dictated by common sense, and it is to be hoped and expected that they speedily will become the prevailing usage.

Geographical names are also undergoing a revision both here and abroad. There has been heretofore a most perplexing diversity in the spelling of many of them. Names of places in Asia or northern Africa, which are written by their inhabitants in Arabic or some other Eastern language, must be transliterated when they appear in the Roman alphabet. English-speaking geographers would transliterate these names after the analogies of their own language, French geographers would follow the different usage of their language, and the Germans would do likewise. If any language admitted an alternative way of spelling, some author would be sure to adopt it; so that, in the case of an important town in Syria (Beirut), no less than twelve ways of spelling its name have arisen among Western peoples.

Then there were names of places, rivers, etc., in the unwritten native languages of Africa, the Pacific islands, and America, concerning which the same diversity has prevailed. Sometimes a strange spelling has had the force to bring in a mispronunciation. The early English explorers found a nation of Indians in eastern North America whose name they spelled *Algonkin.* The French explorers, having no *k* in their language, and being accustomed to represent the *k*-sound by *qu,* spelled the same name *Algonquin.* Both spellings persist to this day, and many among us, the descendants of the Englishmen, having become acquainted with the form *Algonquin* through the eye and not through the ear, have given the *qu* its English value in pronouncing the word, and say wrongly, "*Algonkwin.*"

In 1885 the Council of the Royal Geographical Society of England began a movement in behalf of systematic spelling in geographical names, which has yielded most gratifying results. The society adopted a system having the same basis that is employed for all scientific modes of spelling, namely, vowels pronounced as in Italian (or German), and consonants as in English. This system has been adopted by the British Admiralty Office, by the War, Foreign, and Colonial Offices, and by the last has been recommended to the colonies.

In September, 1890, the United States Board on Geographic Names was created by order of the President of the United States, for the purpose of securing uniformity of geographical nomenclature in Government publications.

The board consists of ten officials in the departments at Washington, with Prof. Thomas C. Mendenhall, Superintendent of the United States Coast and Geodetic Survey, as chairman. For spelling names from Oriental or unwritten languages, this board has adopted a system practically identical with that used by the British Government offices. Since France, Germany, and Spain have adopted methods substantially the same as this, the great map-making nations of the world are now in close agreement as to geographical spelling. The alphabet is used as follows by the board in representing the sounds of Oriental and unwritten languages: *a* as in f*a*ther (Java, Somáli), *e* as in m*e*n (Tel el Kebír), *i* as in rav*i*ne (Fiji), *o* as in m*o*te, and *u* as *oo* in b*oo*t. All vowels are shortened in sound when the following consonant is doubled. (Yarra, Jidda). Doubling a vowel is necessary only where there is a distinct repetition of its sound. English *i* in *i*ce is represented by *ai* (Shanghai), *au* represents *ow* in h*ow* (Fuchau), *ao* is slightly different from *au* (Nanao), and *ei* is scarcely to be distinguished from *ey* in th*ey* (Beirút).

Among the consonants, *b*, *d*, *l*, *m*, *n*, *p*, *r*, *s*, *t*, *v*, *w*, *x*, and *z* are the same as in English; *c* is always soft (Celebes), *ch* as in *ch*urch (Chingchin), *f* as in English, and its sound is never represented by *ph* (Haifong), *g* is always hard, *h* is always pronounced when inserted, *j* as in English, and its sound is never represented by *dj* (Jinchuen), *k* as in English, and always takes the place of hard *c* (Korea), *kh* stands for the Oriental guttural (Khan), *gh* is another guttural as in the Turkish (Dagh, Ghazi), *ng* as in fi*ng*er, also as in si*ng*er, *q* is not used, *qu* being replaced by *kw* (Kwangtung), *y* is always a consonant and is to be replaced by *i* wherever it has been used as a vowel (Mikindani). Accents should not generally be used, but where there is a very decided emphatic syllable or stress which affects the sound of the word it should be marked by an acute accent (Galápagos, Saráwak).

With regard to names in the United States the policy of the

board is to make no changes unless a decided improvement can be secured thereby. Its first principle is that the spelling and pronunciation which are sanctioned by local usage should be adopted in general. Even where the present name is a changed or corrupted one, if it has become firmly established the board keeps its hands off. But where a choice is offered between two or more names for the same locality, all sanctioned by local usage, the opportunity to secure the most appropriate and euphonious one is improved. The possessive form of names is discarded wherever practicable, sometimes by dropping both the (') and the *s*, for instance changing *Gedney's* to *Gedney* Channel, in New York Harbor, and in cases where so much change has not seemed advisable, simply omitting the ('). By the latter procedure, which is practically changing to the plural form, *Minot's Ledge*, in Boston Harbor, becomes *Minots Ledge*. The final *h* is dropped from names ending in *-burgh*, and the ending *-borough* is shortened to *boro*. The spelling *center* is always used rather than *centre*. The board discourages the use of diacritic marks over letters, and hyphens between parts of names; where a name consists of more than one word it prefers to combine the parts into one. The use of the words *City*, *Town*, and *Court House* (abbreviated *C. H.*) as parts of place-names is deemed undesirable.

The first report of the board has been issued recently and contains a list of decisions made during the year which it covers. More than two thousand questions have been submitted to the board, and decisions have been given upon nearly all of them. Early in the year it was called upon to decide concerning several hundred names in Alaska, where the utmost confusion exists concerning geographic nomenclature. To the difficulty of transliterating Russian and Indian words into English letters is added the confusion caused by the fact that expedition after expedition, exploring this region, has assigned new names to the geographic features of the country, ignoring those already given. This state of affairs has induced the board to undertake a complete revision of Alaskan names, the result of which will be a geographical dictionary of the Territory. One of the three bulletins issued during the year contained a list of between five and six hundred decisions rendered at the instance of the Lighthouse Board, and fully a thousand questions were answered for the Census Office. The names of all the counties in the United States have been passed upon, and the approved list appears in the report.

Among the United States names that have been revised are: *Bering* (Sea and Strait), in place of *Behring*, the *h* being a German addition to the original Danish name: *Fort Monroe*, this, not *Fortress Monroe*, being the name given to the works at Old Point Comfort by the Secretary of War in 1828; *Pedee*, for the river

formerly called *Great Pedee; Pittsburg* (Pa.), without final *h*, this being really the official form of the city's name; *Mohave* instead of the Spanish form *Mojave*, and *Blackwells Island* in place of *Blackwell's*. *Wood's Holl*, the meaningless corruption of *Wood's Hole* effected by finical summer visitors, is not meddled with except to drop the apostrophe.

Among foreign names *Colon* has been adopted, to the exclusion of *Aspinwall*, *Bermuda* instead of *The Bermudas*, and *Salvador* (Central America) for *San Salvador*. The spelling *Fiji* is preferred to the now antiquated *Feejee; Baluchistan* has been adopted for *Beloochistan;* and a few other accepted spellings are *Kaffraria*, *Chile*, *Haiti*, *Kamerun* (Cameroon), *Kashmir*, *Kongo*, *Puerto Rico*, *Sind* (Sindh), and *Tokyo*.

The accepted forms are used by the Coast and Geodetic Survey, on its charts of the coasts of the United States; the Hydrographic Office of the Navy Department, on the charts of foreign coasts that it publishes; the Geological Survey, which is making a mother-map of the United States; the General Land Office, which compiles from its plats maps of most of the States and Territories; and the Post-Office Department, which decides the names of all post-offices. They are used more or less also by nearly every other bureau of the General Government—in fact, wherever geographical names occur in all printing done at the Government printing-office.

The new forms are also coming into use rapidly among publishers of books and newspapers and the general public. The American Book Company, which furnishes the greater portion of the school-books used in this country, has adopted the decisions of the board for all its text-books on geography. Publishers of atlases and other geographical works generally are using them, so that in a few years it will be easy to tell that a map is old from the fact that the old forms of names are engraved on it. Many newspapers also, that have received copies of the first report of the board, have stated that they should follow it.

The good work of the chemists and geographers in the interest of simplicity and uniformity gives hope that similar changes may be made in other classes of words. Medical terms might come next. Few persons would be sorry to see the *æ* and *œ* replaced by *e* and the silent consonants omitted in "hæmor*rh*age," "gynæcology," "œsophagus," "diar*rh*œa," "*ph*thisis," "*p*neumonia," "*rh*eumatism," "*p*tyalism," "*p*sora," etc. There is a growing tendency toward such simplifications on all sides, and the direct efforts that are being made in this direction are only furthering the progress of a natural evolution. It has been said that we ought to wait for these changes until the natural process makes them; but if men want to put city streets and blocks where

there is a hill, they do not wait for geological agencies to level the hill. They go at it with steam-shovels, drills, and dynamite. Another objection that is made to all simplifications of spelling is that they remove the marks of derivation in words. In many cases this is untrue; in the others it is of no consequence. The Italian sees the Greek φωτός and γράφειν just as plainly in his *fotografia* as the Anglo-Saxon does in his *photograph*. As for the marks of derivation from Old French, the Teutonic languages, Arabic, etc., the majority of persons do not see them at all, and those who do and can interpret them are above the need of such aids. It is with words very much as with men. The influence of heredity makes it instructive to know the character of a man's parents and grandparents, but men do not go to business every day carrying charts on which their family trees are delineated. So with words; in every-day use only their present values concern us, and their histories should be left to the dictionaries as family trees are left to genealogical records.

A general simplification of English spelling promises to be one of the events of the near future. Articles in favor of it are appearing with increasing frequency in our leading magazines, the latest being by Brander Matthews, in Harpers' Magazine for July. The philologists as a body desire the change, and there is not one linguistic scholar of any prominence who opposes it. When publishing firms nowadays select editors to make or revise our leading dictionaries, they get spelling reformers, for all the men competent to do such work are of this class. The late President Porter, who edited the International Webster, has expressed himself in favor of simplification; Prof. W. D. Whitney, editor-in-chief, and several of the other editors of the Century Dictionary, are active workers for this reform; Prof. F. A. March, who is in charge of the departments of spelling and pronunciation in the forthcoming Standard Dictionary, is President of the Spelling Reform Association, and many of the collaborators on this work believe in logical spelling. In England, Dr. James A. H. Murray, editor-in-chief of the Philological Society's Dictionary, the greatest lexicographic work on the English language ever undertaken, is an unhesitating advocate of orthographic reform, as is Prof. Walter W. Skeat, author of the Etymological Dictionary. If English spelling were to be made phonetic next year, or in 1900, a few persons might cry, "Give us back our silent letters," as the mob cried, "Give us back our eleven days," when the calendar was changed from old style to new; but only a few months would pass before all would be asking, "Why was this not done generations ago?"

# CORRESPONDENCE.

## PROPER DIET FOR HOT WEATHER.

*Editor Popular Science Monthly.*

THE article under the above title in your July number appears to be based on chemical theories of nutrition that find no place in the modern science of physiology. The classification of food constituents into proteids or albuminoids, fats, and carbohydrates is a convenient one for certain purposes, but it is now known that these groups of nutrients have not the specific functions that were formerly attributed to them.

The assumption of Dr. Davies (page 366) that "the foods that are converted into heat—that is, keep up the heat of the body—are starches, sugar, and fat, and those that more particularly nourish the nervous and muscular system are the albumen and salts," is a survival of an obsolete theory of respiration; and tables giving the proximate composition of different articles of food are of little value in formulating diets for special purposes.

The law of the conservation of energy is now recognized as a significant factor in all physiological processes, and it furnishes the only consistent explanation of the phenomena of animal heat. The energy used in the constructive processes is stored up as potential energy, as an essential condition or constituent of all organic substances, and on their disintegration in the processes of destructive metabolism it is liberated in the form of heat—as in the digestion of foods, and in the wear and tear of the tissues that are constantly taking place in all vital activities.

Animal heat is not produced by a combustion of certain food constituents that serve as fuel, but it is the result of the liberation of the stored energy of foods and tissues, in the disintegrating processes they undergo in the system. Dr. M. Foster, who is recognized as one of the best authorities in physiology, estimates the potential energy of food constituents as follows:

| | | | |
|---|---|---|---|
| 1 gramme | proteids | = 4,500 | calories, |
| 1 " | fat | = 9,000 | " |
| 1 " | carbohydrates | = 4,000 | " |

From this it appears that the "starches and sugars," which are included in the group of carbohydrates, contain less potential energy than the proteids, and the heat obtained from them is accordingly less. The inference that starch and sugar should be avoided in hot weather, and largely replaced by lean meat, which consists in the main of proteids or albuminoids, is, therefore, not warranted by the evidence in regard to their constitution.

Without noticing the numerous fallacies in the article in question, attention is called to the widely different conclusions reached by Dr. Foster, in the last edition of his Physiology, in discussing the adaptations of diets to climatic conditions, and to the requirements of the system in brain-work and severe muscular labor.

He says: "With regard to climate the chief considerations attach to temperature. When the body is exposed to a low temperature, the general metabolism of the body is increased, owing to a regulative action of the nervous system. We might infer from this that more food is necessary in cold climates; and, since the increase in the metabolism appears to manifest itself chiefly in a greater discharge of carbonic acid, and therefore to be especially a carbon metabolism, we might infer that the carbon elements of food should be especially increased. When the body is exposed to high temperatures the same reflex mechanism tends to lower the metabolism; but the effects in this direction are much less clear than those of cold, and soon reach their limits; the bodily temperature is maintained constant under the influence of surrounding warmth *not so much by diminished production as by increased loss.* We may infer from this that in warm climates not less, but if anything, rather more food than in temperate climates is necessary in order to supply the perspiration needed for the *greater evaporation and discharge of heat by the skin.* . . . Indeed, the evidence that the increase of metabolism provoked by cold bears exclusively on carbon constituents, is so uncertain that it may be doubted whether any change in the normal diet, beyond some increase in the whole, should be made to meet a cold climate. Similar reasons would lead one to infer that man in the warmer climate would maintain on the whole the same normal diet, *the only change perhaps being to increase it slightly, possibly throwing the increase chiefly on the carbohydrates* with *the special view* of *furthering* perspiration. . . .

"In choosing a diet for muscular labor we must have in view *not the muscle itself, but the whole organism.* And although it is possible that future research may suggest minor changes in the various components of a normal diet, such as would lessen the strain during labor on this or that part of the body, on the muscles as well as on other organs, our present knowledge would rather lead us to conclude that what is good for the organism in comparative rest is good also for the organism in arduous work; that the diet, normal for the former condition, would need for the latter a limited total increase, but no striking change in its composition. . . . The principles of such a conclusion with regard to mus-

cular work may be applied with still greater confidence to nervous or mental work. The actual expenditure of energy in nervous work is relatively small, but the indirect influence on the economy is very great. The closeness and intricacies of the ties which bind all parts of the body together are very clearly shown by the well-known tendency of so-called brain-work to derange the digestive and metabolic activities of the body; and *if there be any diet especially suited for intellectual labor, it is one directed not in any way toward the brain, but entirely toward lightening the labors of and smoothing the way for such parts of the body as the stomach and the liver.*"

It is evident from these statements that our present knowledge of the physiology of nutrition does not warrant any prescriptions of special food constituents for the assumed varying requirements of the system under different climatic conditions or for different kinds of work.

Individual peculiarities and inherited habits of the system are prominent factors in the processes of nutrition, and experience is a safer guide in regulating one's diet than any theories based on the chemical composition of foods. Yours truly,

MANLY MILES.

LANSING, MICH.

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### THE PROTECTION OF BRAKEMEN.

*Editor Popular Science Monthly:*

SIR: By the omission of a line in printing the note I made to my suggestion as to the protection of brakemen against mutilation by accidents in coupling freight-cars (which escaped me in the proof), my suggestion itself loses whatever force it might have, I think, by being too exemplary. My suggestion was (page 222 of The Popular Science Monthly for June, 1892) that a statute might be provided requiring the draw-heads of all freight-cars manufactured or admitted into the United States to be of a uniform height and to be within projecting frame corners from the rail surface, everybody can see that not only humanity but perfect justice both to the railway company and to the employé would be subserved.

The note I added should read as follows: I think such a law as this would be a better one than one directing the use of an automatic coupler, for it would not throw any brakemen out of their jobs. As to the loss of life spoken of by the President, the larger number of instances will, I think, be found to have occurred at night, when brakemen, not knowing of course the height of the draw-heads of the cars approaching them, and often while using every precaution, might be caught and crushed by a different build of car with flush corners, or higher or lower timbered corners. Such a law, prescribing uniformity in this detail, and mulcting the company owning the car or cars causing the death or mutilation, by reason of its willful omission to observe the provisions of that law, with adequate damages, would be, I think, a salutary and an exemplary one.

Since the matter is one which certainly calls for attention, I should be glad if you would insert this letter in your next issue.

Yours, etc.,

APPLETON MORGAN.

NEW YORK, *June* 1, 1892.

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## EDITOR'S TABLE.

### *POLITICAL PROGRESS.*

WHEN we look back over the history of this country since the close of the civil war we find, on the whole, ample cause for satisfaction and encouragement. Those who look for perfection in the working of political institutions are doomed to disappointment. Happy is the nation that, as the years and decades slip by, can count some solid gains for the cause of good government and national morality, even though many parts of the political machine may work faultily, and many evil tendencies manifest themselves from time to time. After the war, we entered upon a period of almost shameless political corruption, not only in national but in State and municipal affairs as well. To say that we have completely thrown off the disease of corruption would be, we fear, to say too much; but that a very considerable purification has been effected, especially in connection with the national Government, no one can doubt. Too many individuals throughout the community are indeed indifferent to this evil, and many are ready to make all kinds of apologies for it, as something that can not be dispensed with in con-

nection with popular institutions; but in some way or other the nation, as a whole, has set its face against it, and the suspicion of being systematically corrupt—that is to say, of practicing, or being prepared to practice, corruption in the administration of the national Government—would be fatal to either political party.

Twenty years ago the "spoils system" was in full force. Every office under the Government was virtually used for purposes of bribery. It was bestowed in the first place as a reward for fidelity to party, and the salary attached to it was afterward assessed for contributions to the party funds. The sense of decency of the people has risen up in revolt against this abomination, and, though the principles of civil-service reform have not yet been carried far enough, the great body of the national civil service has been placed on an independent and honorable footing. No party manager can now fry the meager "fat" out of the smaller office-holders for political purposes; the only persons to whom that process can at present be applied are the higher functionaries and the protected manufacturers. The result of this partial yet extensive reform of the civil service has been a considerable increase in the efficiency of the public departments. The public interest is now kept in view where formerly there was little thought of anything save how to make an office temporarily held of as much advantage as possible to the holder. The effect on the self-respect of the service is already marked, and we can not doubt that it will become more so as years go on.

But there is further progress yet to be made. The perfection of any machine is to consist of the fewest parts—in other words, to be as simple as possible in construction—and to accomplish its work with the least possible loss of energy. In judging of our political and administrative institutions we can not keep this analogy too closely in view. But here arises a prior question: What is the work which our political machine should be set to accomplish? Is it, for example, to regulate the whole industrial and commercial life of the people? If so, adieu all hope of simplicity of construction! Adieu, we may add, all hope of any efficient performance of so huge, so unlimited a task. As has often been pointed out—more than once in these columns—the system of taking certain industries under the protection and patronage of the state is, in itself, a species of corruption, and has its natural result in special acts of gross corruption. What will a wealthy manufacturer, whose profits depend in large measure upon a tariff enacted for his special benefit, not do for the party that made and maintains the tariff? The thing is too obvious to need insisting on. The more help a party receives from the controllers of tariff-fed industries the more independent it is of the people; and it is for the people to see to it that they are not strangled in cords of their own making. The governing power in a state ought to be under no obligations of any kind to individuals, corporations, or interests within the state; it should stand aloof from all these, in order that it may do justice to all without fear or favor, without prejudice or partiality. Until this condition prevails it is absolutely impossible that we should have honest government in the full sense of the word. It is evident then what the next step in the purification of our national life must be: it is the freeing of the governing power from all dependence on, and all entangling alliances with, private interests. We believe that, were this done, a higher standard of public duty and a nobler tone of public life would at once be established; and we should begin to see more clearly how, in other respects, our administrative methods might be improved. The ideal of a free state is the largest possible measure at once of liberty and security for the individual citizen, and

the widest possible scope for spontaneous social activities. We are well aware that, even in this enlightened community, not every citizen takes this view of the matter; that the old idea of government as a kind of earthly Providence to whom prayers may be addressed on all possible subjects, and whose powers of interference with the natural course of things are, and should be, unlimited, more or less prevails. We trust, however, that this antiquated notion is on the wane, and that within the next few years our people will take a decided step in advance in freeing themselves from the thrall of unnecessary state interference with individual action. We shall never know what, as a people, we are capable of till we take our industrial and commercial activities into our own hands, and instruct our legislators that we shall not in future consider it one of their tasks to make this country wealthy and prosperous.

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### *MORAL ENDEAVOR.*

THERE has recently sprung into existence a society of vast extent, the professed purpose of which is to promote the doing of good deeds by its members. We refer to the Society of Christian Endeavor, a monster convention of which was held in this city two month ago. So far as its main object goes, it is impossible to find any fault, even were one so disposed, with the Society of Christian Endeavor. One is only tempted to ask a little mournfully why it should be thought necessary to join a society in order to feel prompted to good deeds. We all belong to a society far vaster than that of Christian Endeavor—we are all members of the great human society. Through our membership therein we reap a constant succession of benefits of the most important character; and the question we should put to ourselves, if we have not already put it, is whether our personal attitude toward that great society is what it ought to be. It can not be what it ought to be unless we vividly realize the benefits our membership entails. To the human society we are indebted for peace and security, the protection of life and property, scope for the development of family and personal affections, access to the means of intellectual and moral growth, opportunities for æsthetic enjoyment—in a word, all that enters into the great name *civilization*. Without this society into which we are all born members we should recede into a barbarism more primitive than that of our flint-fashioning ancestors, for even they lived in societies. Language would leave us, and, with language, all higher rationality.

This great human society, like other organizations, works under conditions, and, vast as are the benefits it now confers upon us, they are not what they would be if each member consciously endeavored to advance the ends for which the society exists. It is worth while to pause a moment and think what life would be if every member of the human society were a working member in the best sense; if, by a faithful performance of duty and a kindly bearing toward our fellow-men, we were all trying to bring our society to perfection. Does any one say that the human society is too big for one to feel any affection or loyalty toward it? If so, it is not wisely said. The Society of Christian Endeavor is getting to be very big indeed—running into the millions—but is the interest in it lessening on that account? We do not hear that it is. In point of fact the human society is not too big for many to feel a deep interest in it already; and we are persuaded that, if only its claims were properly presented, multitudes could be brought to profess their allegiance to it. Every day of life thousands, nay millions, of deeds are done consciously or unconsciously in the name of humanity—that is to say, with no other feeling or motive than a desire to do

good to the world at large. What is wanted is a vast extension of this feeling and the raising of unconscious service to the human society to conscious service. Who, indeed, that is not a criminal by nature would say: "I am wholly indifferent to the welfare of the social organism; if, by a slight effort, I could improve the conditions of life for numbers of my fellow-men, I would not do it"? If, then, we feel that selfish indifference to the general weal makes a man virtually a criminal and an outlaw, nothing should be required to spur us to a more diligent performance of our social duties than to be reminded from time to time of our membership in that vast society which comprises the human race, and whose constitution and by-laws are written in the civilization of our time. There is an *esprit de corps* which should animate every intelligent member of civilized society and which should make the performance of any service toward society, or toward any member of it, a pleasure. We certainly approve of the ends which the Society of Christian Endeavor sets before itself; but, in so far as it tends to obscure the antecedent obligation of every human being who lives *by* society to live also *for* society, it may, in spite of its admirable aims, be found working against rather than for the true progress of the race.

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### *POSITIVISM IN FRANCE.*

Most of our readers are probably aware that the name "positivism" was given by the French philosopher, Auguste Comte, to a system of thought and life which he professed to have founded on the unmistakable teachings of science. According to his view, the world had passed through the stages of intellectual childhood (theology) and adolescence (metaphysics), and had entered upon its maturity, the distinguishing mark of which would be the acceptance and systematic application of duly verified scientific truth. That Comte was a powerful thinker, with an altogether singular faculty for generalization, no one has ever been disposed to deny; and, although the scientific world in general has stood aloof from his system of thought as something too finished and definitive, and therefore too restrictive, for such an era of intellectual growth and expansion as the present, it has watched, not without sympathy, the efforts of his avowed followers to uphold the claims of science to a controlling voice in human affairs, and to promote the higher intellectual and moral life of society by means of popular lectures of a superior character. On the other hand, positivism has earned the hatred of the ecclesiastical foes of modern thought by the absoluteness of its rejection of their claims and pretensions. It is, therefore, an event of no ordinary importance that the leader of positivism in France, the man whom Auguste Comte designated as his successor, should have been selected by the Minister of Public Instruction to fill the newly created chair of the General History of the Sciences at the Collége de France, the most distinguished educational institution in the country. The chair was created, it is generally understood, with the express intention of offering it to M. Lafitte; and when the appointment was made it was greeted with almost unanimous approval by the press. Ecclesiastical journals, like the Univers, of course objected, and the Minister of Public Instruction had to answer some interpellations in the legislature; but, on the whole, the Government had every reason to congratulate itself on the effect produced on the public mind. Some of the comments of the Paris press are indeed very striking, showing a freedom in the expression of opinion to which in this country or in England the public is scarcely accustomed. "In these days of mystical reaction," says one paper (La Justice), "it was a very suitable thing to take strong ground for the positive and scientific spirit, and to proclaim

in clear and lofty tones the one true religion, that which exalts the claims of humanity and of social duty." In defending his appointment in the Senate, the Minister of Public Instruction, after dwelling upon the intellectual qualifications of his nominee, paid the following tribute to his character: "Truly, if there is among us a modest man, a simple man, a man who has never courted notoriety, and who has reached his seventieth year without ever having asked anything of his country, it is M. Lafitte; and, for that reason, this modest and conscientious scholar, this *savant*, whose whole life has been devoted to disinterested study, appeared to us to present the moral as well as the intellectual characteristics necessary for the high dignity of a professor in the Collége de France." Again, speaking of positivism as a system, he observed: "This positivist doctrine, that people talk about and that some execrate, is an extremely tolerant doctrine; you may say that tolerance lies at its very base. Its absolute rule is to proceed by means of observation and experiment; to limit its conclusions and its affirmations to what is revealed to it by these special scientific methods; and, as regards what lies beyond verification, to treat with respect every belief and every hypothesis. Positivism is, therefore, from the philosophical point of view what the unsectarian, or lay state is from the political point of view; and I did not, therefore, think that M. Lafitte's profession of this doctrine should alarm or disturb men's consciences in this country, or prevent me from nominating him to a chair of which he was worthy."

These are notable words to have been spoken by a responsible minister in a country in which not long ago ecclesiasticism was so powerful. It is not necessary to have adopted, or to approve of, the peculiarities which mark positivism in its intellectual, and especially in its practical aspects, in order to rejoice that its most eminent teacher should have an opportunity of exhibiting its broader principles from the vantage-ground now afforded him, and of thus challenging for them, more openly than ever before, the criticism of the philosophical world. As to the action of the French Government, we can only applaud the determination it shows to place all competently represented systems of thought upon a footing of perfect equality.

## LITERARY NOTICES.

MARRIAGE AND DISEASE. By S. A. K. STRAHAN, M. D. New York: D. Appleton & Co. Pp. 326. Price, $1.25.

A SUBJECT for which the progress of science is just beginning to obtain intelligent consideration is the transmission of defects from parents to offspring. While most persons have a hazy belief in the adage, "Like father, like son," comparatively few have any adequate conception of the remorseless certainty with which the physical and mental defects of parents produce degeneracy and early death in their children. The present work furnishes in a form available for the general reader an abundance of pertinent and well-authenticated facts concerning the above subject. The author states first what is known as to the general laws of heredity, and then proceeds to discuss in turn insanity, drunkenness, epilepsy, and other diseases and defects with relation to parenthood. "There is no class of diseases," he says, "so surely transmitted from parent to child as the nervous." While the chronically insane are not allowed to contract marriage, yet a young man, for instance, who inherits nervous instability may, in the intervals between acute attacks of insanity, marry and beget children. When, as probably happens, he goes to end his days in an asylum, he is very likely to be followed by some of the children whom he has burdened with his infirmity. The results are more surely disastrous when both parents belong to the neurotic or insane type. "The person, man or woman," says Dr. Strahan, "who has an epileptic, or choreic, or imbecile brother or sister, an insane uncle, aunt, or parent, or even grandparent,

should never for a moment permit himself to look upon a member of any neurotic family —that is, one in which insanity, epilepsy, habitual drunkenness, suicide, or imbecility has at any time appeared—as a probable, or even possible, partner in marriage. . . . All these diseases, together with neuralgia, hysteria, cancer, and the like, are allied, and, following some law at present unknown to us, replace each other in successive generations, and in different individuals of the same generation, in a manner at present inexplicable."

In the chapter on tubercular disease, the causes which produce the consumptive temperament are given as impure air, drunkenness, and want among the poor; dissipation and enervating luxuries among the rich. This temperament occurs in families that are on the down grade of general decay. Among instinctive criminals, which are regarded as representatives of a decaying race, tubercular disease, very naturally, is found actively at work.

In the concluding chapters of the work it is shown that too early and too late marriages have an injurious effect on the offspring of such unions, while consanguineous marriages injure the children proceeding from them only by intensifying whatever defect may characterize the family to which the parents belong. Attention is called to the fact that unions of the criminal, the dissolute, and the intemperate bring forth children whose degenerate organizations make them burdensome and dangerous to those of more wholesome parentage. On the basis of these facts Dr. Strahan urges those who perceive that they possess any serious constitutional taint to forego marriage, and advocates the confinement of the criminal and habitually drunken so as to prevent the propagation of their kind.

BIBLIOGRAPHY OF THE ALGONQUIAN LANGUAGES. By JAMES CONSTANTINE PILLING. Washington: Government Printing-Office. Pp. 614.

WE have already noticed the four previous numbers of the author's series of bibliographies of Indian languages—those of the Eskimauan, Siouan, Iroquoian, and Muskogean families. The whole have grown out of an attempt made several years ago to embrace within a single volume an author's catalogue of all the material relating to the native North American languages. Too much material was collected for a single convenient volume, and it was concluded to change the style of publication and issue a series of bibliographies, each relating to one of the more prominent groups of our native languages. The Algonquian-speaking people perhaps covered a greater extent of country than those of any other of the linguistic stocks of North America; and the literature of their languages is greatest in extent of any of the stocks north of Mexico, being equaled, if at all, by only one south of that line, the Nahuatl. Probably every language of the family is on record, and of the more prominent, extensive record has been made. The whole Bible has been printed in the Massachusetts and Cree languages, nearly the whole in the Chippewa and Micmac, and portions of it in a number of others. Rather extensive dictionaries have been printed in Abnaki, Blackfoot, Chippewa, Cree, Delaware, Micmac, and Nipissing, and manuscript dictionaries are in existence of Abnaki, Nipissing, Blackfoot, Chippewa, Cree, Illinois, Massachusetts, Montagnais, and Pottawatomi; grammars of the Abnaki, Blackfoot, Chippewa, Cree, Massachusetts, Micmac, and Nipissing; and manuscript grammars exist of the Illinois, Menomenee, Montagnais, and Pottawatomi. Prayer-books, hymn-books, tracts, and scriptural texts have appeared in nearly every language of the family; several of them are represented by primers, spellers, and readers; and a geography for beginners was printed in Chippewa in 1840. The present volume contains 2,245 entries of titles, of which 1,926 relate to printed books and articles, and 319 to manuscripts. Of these, 2,014 have been seen and described by the compiler; and of those unseen by him, titles and descriptions of probably half have been received from persons who have actually seen them and described them for him. Many full titles of printed covers are also given, and fac-similes of the original. The author has sought to include everything, printed or in manuscript, relating to the Algonquian languages—books, pamphlets, articles in magazines, tracts, serials, etc., and such reviews and announcements of publications as seemed worthy of notice.

BULLETIN OF THE UNITED STATES FISH COMMISSION FOR 1889. Washington: United States Commission of Fish and Fisheries. Pp. 504.

THE contents of this volume consist of some twenty reports on various subjects connected with American fishes and fisheries, including the taking of shell-fish. Among the more extended papers is one on the salmon and salmon fisheries of Alaska, by T. H. Bean, which is copiously illustrated with views and maps. As the salmon fisheries of Alaska are said to be more valuable than the seal fisheries, the act of Congress ordering the commissioner to make this investigation, with a view to protecting the industry, would seem to be a wise one. There is a Report upon a Physical Investigation of the Waters off the Southern Coast of New England, by William Libbey, Jr., accompanied by a large number of tables and temperature charts. Other notable papers are, A Reconnaissance of the Streams and Lakes of the Yellowstone National Park, by David Starr Jordan, with views of streams and cataracts; Notes on the Crab Fishery of Crisfield, Md., by Hugh M. Smith; and Notes on the Oyster Fishery of Connecticut, by J. W. Collins, the two last named also being well illustrated.

TENTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY, 1888–'89. J. W. POWELL, Director. Part I, Geology; Part II, Irrigation. Washington: Department of the Interior.

DURING the year covered by this report, work was prosecuted in the many divisions of the survey already established, and in the new division of irrigation, created to perform the new duties assigned to the survey by Congress at the beginning of the year. The publications printed for the survey were one annual report, two quarto monographs, nine bulletins, and one annual statistical volume. In accordance with a plan promulgated by the director in December, a conference on map publication was held in January, at which a unit of publication, a system of nomenclature, and sets of colors and patterns for geological maps were determined upon. The decisions reached, and plates showing the colors and patterns, are inserted in the report. The director's report is followed by administrative reports of the heads of divisions, and by these papers: General Account of the Freshwater Morasses of the United States, with a Description of the Dismal Swamp District of Virginia and North Carolina, by Nathaniel Southgate Shaler; The Penokee Iron-bearing Series of Michigan and Wisconsin, by the late Roland Duer Irving and Charles Richard Van Hise; The Fauna of the Lower Cambrian or Olenellus Zone, by Charles D. Walcott. The papers are illustrated by ninety-eight plates and many figures and maps.

The report on irrigation is bound separately, and describes the first year's work in this field. The area of the arid region of the United States is about 1,300,000 square miles—one third of the whole country. Major Powell estimates that 150,000 square miles of this, equal to half the present cultivated area of the country, is so favorably situated that it may be reclaimed by irrigation within a generation. The efforts of the persons assigned to the irrigation survey were directed during the year to ascertaining the whereabouts of irrigable land most eligible for redemption and segregating it for homestead settlement; to determining the amount of available water, the best locations for reservoirs and canals, the seepage, the evaporation, and the vested rights—in short, the most economical method of bringing the land and the water together. The details of this work are set forth in the report.

PSYCHOLOGY APPLIED TO THE ART OF TEACHING. By JOSEPH BALDWIN, LL. D. International Education Series, Vol. XIX. New York: D. Appleton & Co. Pp. 381. Price, $1.50.

THE process of training the mind is here presented in a thoroughly methodical manner. The author divides his treatise into six parts, the first five of which deal respectively with the education of the perceptive powers, the representative powers, the thought powers, the emotions, and the will powers. These several subjects are systematically divided and subdivided, and under each subdivision the author tells in terse, vigorous sentences just what the teacher should do. For an example of his method take the following, from the chapter on Culture of the Perceptive Powers:

*Habits of Exact Observation.*—These habits should be formed in early life. Discriminations

and assimilations should be as exact as possible, and this exactness should be rooted into habit.

1. *Sense-observation.* Great attention should be given to educating learners to gain exact sense-ideas through each sense. The power and accuracy of memory, imagination, and thought depend largely upon the extent and exactness of our sense-knowledge. Merchants must be able to test the quality of their goods by their senses. Mechanics, cooks, artists, poets, need to have the power of exact sense-observation well developed. Habits of exact observation should be cultivated early in life, and maintained persistently. Gazing around at everything, and listening to every sound, are not meant by this, but a careful attention to details, plans, and purposes.

Large use is made of tabular statements, diagrams, and different styles of type in presenting the author's meaning. The closing portion of the work, on The Art of Teaching, consists of seven short chapters. In the second of these Prof. Baldwin states and comments upon the following "Nine Laws of Teaching": "1. Be what you would have your children become. 2. Know thoroughly the children and the subject. 3. Use easy words and apt illustrations. 4. Secure attention through interest. 5. By easy steps lead through the known to the unknown. 6. Lead learners to find out, to tell, and to do for themselves. 7. Train learners to assimilate into unity their acquisitions. 8. Train pupils to habitually do their best, in the best ways. 9. Lead the pupil through right ideas to right conduct." He then proceeds to define the fundamental teaching processes, and to state which are to be most largely employed in the several periods of education. This work, with the author's two earlier books, on the Art of School Management, and Elementary Psychology, form a series in elementary pedagogy. During the past forty years the chapters of the present volume have been given as lessons to many classes of teachers, and they are now fixed in the form in which the author believes they will be most helpful.

A Treatise on Electricity and Magnetism. By James Clerk Maxwell. Third edition. In two volumes. New York: Macmillan & Co. Price, $8.

That a work on electricity in this generation of electrical progress should still continue to be printed twenty years after it was written, and ten years after the death of its author, is an indication of sterling worth. Although a treatise like this, dealing only with the mathematics of electricity, is not so liable to become antiquated as one treating of the theories and applications of the science, yet Maxwell's book had a distinct forward trend which has contributed much to its longevity. The editor of the present edition, Prof. J. J. Thomson, says in his preface that the advances made by electricity and magnetism in the last twenty years are "in no small degree due to the views introduced into these sciences by this book; many of its paragraphs have served as the starting-points of important investigations"; and further, that "all recent investigations have tended to confirm in the most remarkable way the views advanced by Maxwell." In revising this work Prof. Thomson has added foot-notes relating to isolated points which could be dealt with briefly, but the chief advances in electricity that have been made since the publication of the first edition are to be treated more consecutively in a supplementary volume. He has added some explanations to the argument in passages where he has found that students meet with difficulties. He has also attempted to verify the results that Maxwell gives without proof, and where he arrives at different results has indicated the difference in a foot-note.

Longmans' New School Atlas. Edited by George G. Chisholm and C. H. Leete. New York: Longmans, Green & Co. Price, $1.50.

There are thirty-eight maps in this atlas, most of them being on double-page sheets, measuring about fourteen by eleven inches, and a few being on longer folded sheets. Coloring and a variety of markings are used so as make to each give a remarkably full description of the lands and waters that it represents. There are seven maps of the world: the first showing the height of land and depth of sea in contours; the second showing ocean currents, periodical rains, and drainage; the third, in four parts, giving isotherms; the fourth showing the mean atmospheric pressure and prevailing winds in January and in July; the fifth, magnetic variation; the sixth, vegetation; and the seventh, in two parts, density of population, races, and religions. The maps of the several countries show political divisions (historical boundaries being

indicated in some cases), height of the land by means of coloring, canals, battle-fields, elevation in feet of important towns, mountain peaks and passes, and the limit of navigation in rivers. There are geological, rainfall, population, industrial, and commercial maps of the United States, and one showing territorial growth, besides the general map of the whole country, and one of the northeastern part on a larger scale. To avoid overloading the maps, names of unimportant places are not printed on them, but such places may be found by means of the index, in which their locations are indicated. A sheet of astronomical diagrams is prefixed to the maps, and the volume has a thumb-index.

A MANUAL OF NORTH AMERICAN BUTTERFLIES. By CHARLES J. MAYNARD. Boston: De Wolfe, Fiske & Co. Pp. 226. Price, $1.50.

INTENDING his book for the tyro as well as for the advanced student, the author has avoided the use of technical terms as far as possible. He has also made his descriptions as short as possible, and in the interest of clearness has used the comparative method wherever he could do so. The volume contains ten hand-colored plates, on which one species of nearly all the genera of North American butterflies are figured, and woodcuts are inserted in the text showing some peculiar character of about two hundred and fifty more species, by which the insects may be known. Both plates and woodcuts, with one exception, have been drawn and engraved by the author. The arrangement used is that published by Mr. W. H. Edwards in 1884.

The Rural Publishing Company, New York, publish in their Rural Library—a series of monthly issues of popular pamphlets on scientific and practical topics in agriculture and horticulture—a well-studied paper on *Cross-breeding and Hybridizing*, by *L. H. Bailey*. It considers the philosophy of the crossing of plants, with reference to their improvement under cultivation, first summarizing the results of the studies of Darwin and other authors who have investigated the subject; then setting forth the advantages of crossing within the variety and change of stock within ordinary bounds; and, finally, going on to the summary production of new varieties. This is a difficult and delicate process, calling for the exercise of the greatest skill and patience. The author records several experiments of his own in the process, all going to illustrate its uncertainty; and concludes: "Encourage in every way crosses within the limits of the variety and in connection with change of stock, expecting increase in vigor and productiveness; hybridize if you wish to experiment, but do it carefully, honestly, and thoroughly, and do not expect too much." A valuable feature of the publication is the copious bibliography of the subject.

A pamphlet comes to us from Italy discussing financial questions and reviewing the situation in that country in particular, entitled *Il Baratto dei Biglietti di Banca fra gli Istituti di Emissione e il Corso forzoso in Italia* (The Exchange of Bank-notes between Institutions of Emission and Forced Circulation in Italy), by the *Avocato Francesco Ciaffii*. The author regards the financial situation of his country as critical, and a forced circulation as imminent.

The periodical formerly known as *The Triangle* now comes to us as *Physical Education*, to which subject it is devoted. The name of the company by which it is published still remains the *Triangle Publishing Company*, and the triangle—denoting the co-operation of body, spirit, and mind—is still the emblem of its school. It purposes to publish chiefly original matter. We are glad to observe it deploring the pushing of records in special lines, refusing to hold up in prominence those who succeed in doing extraordinary work in any single line, and declaring itself committed to all-round work. It also expresses dissent with those who hold that symmetry of bodily form is the great object to be worked for, and with those who look to bodily health as the end of their endeavors. Symmetry of bodily form is an incidental good, and bodily health is only one of the objects to be pursued.

*Food* is a new monthly publication devoted to cookery, household economy, and good living, including foods, dietetics, adulterations, sanitation, regimen for the sick-room, new domestic inventions, and all matters of careful and healthful living, published by the Clover Publishing Company, New York.

The first three numbers, now before us, are filled with bright, suggestive, and practical leading articles on various points in domestic life, and several "departments" containing recipes, sensible household suggestions, hints, and "spicy" items. Price, twenty cents a copy.

*The Journal of Physiology*, edited by *Michael Foster*, with the co-operation of a number of eminent English and American physiologists, continues to publish articles of original research, and stands at the head of publications of this class in the English language. The double number for May contains accounts of investigations of taste, sensations, respiratory changes, retractile cilia in the intestine of *Lumbricus terrestris*, cobra-poison, the influence of calcium salts on heat coagulation of albumins, the protective functions of the skin, etc. Cambridge, England. Price, $5 a volume.

A pamphlet on *How to light a Colliery by Electricity* contains full directions on that subject by *Sydney F. Walker*, author of other papers on electric lighting. It gives directions concerning the number of lamps required, apparatus, dynamos, and their types, the engines that drive them, their position, lamps, switches, cables, faults, and many other points related to the subject. Published in New York by Macmillan & Co. Pp. 36. Price, 75 cents.

Dr. *Daniel G. Brinton* has printed a number of *Studies in South American Native Languages*, being papers which were contributed to the Proceedings of the American Philosophical Society in the early months of 1892. Most of them are based on unpublished manuscripts in European and American libraries, and they include material on at least four linguistic stocks hitherto wholly unknown to students. Dr. Brinton has also added two studies of Mexican languages.

*Physiology: its Science and Philosophy* (The Courier Co., New Castle, Ind.), is an octavo volume in which the author, *Jacob Redding*, M. D., gives his ideas of the philosophy which underlies physiology and disease.

One of the latest efforts to establish a substantial identity of body and soul is contained in a book on *Pluri-Cellular Man*, in which the questions "Whence and what is the intellect, or soul?" "What becomes of the soul?" and "Is it possible to save the soul?" are considered from a biological point of view, by Dr. C. A. Stephens. The author conceives matter as sentient or feeling, and the living body, consequently, as composed of an aggregation of living atoms, or cells. Hence the processes of life have their origins in the beginnings of Nature. The cell "is not only a modicum of protoplasm, but the instrumentality of a self, an *ego*, a personal being." The soul "is the developed and experienced living matter of the body, particularly that in the cells of the nerve ganglia and the brain." The second and third questions proposed are answered in accordance with this doctrince.

The volume of the *Missouri Botanical Garden* for 1892 contains the third annual reports of the Board of Trustees and of the director, *William Trelease*, three anniversary publications, and two scientific papers. We learn from the director's report that the garden has acquired the grasses of the herbarium of the late Dr. George Thurber, Mr. Hitchcock's collection of 2,000 specimens representing the flora of the West Indies, and Mr. Trelease's herbarium of 11,000 specimens representing 4,000 species, mostly of fungi; and the Engelmann Herbarium of about 98,000, and the Bernhardi Herbarium of 57,500 specimens, have been mounted and arranged. The anniversary publications in the volume are the Second Annual Flower Sermon, by the Rev. Montgomery Schuyler; the proceedings of the second annual banquet of the trustees of the Garden, and of the second annual banquet to gardeners. The scientific papers are a revision of North American species of Rumex, by Mr. Trelease, and "the Yucca Moth and Yucca Pollination," by Prof. C. V. Riley, with notes on *Agave Engelmanni* and *Parmelia molliuscula*. Both the papers are excellently illustrated. Price, $1.

One of the fruits of the effort of Mr. Draper, State Superintendent of Public Instruction of New York, to secure comparisons of the school system of that State with those of other States and of foreign countries appears in *French Schools through American Eyes*, which has been prepared at Mr. Draper's request by *J. Russell Parsons*, inspector of teachers' classes, formerly our consul at Aix-la-Chapelle, and author of a

similar book on Prussian schools. Mr. Parsons spent a summer in the study of the French school system, and has presented a clear and comprehensive report on the subject. It is accompanied by a special paper on primary instruction in France. The two reports illustrate the educational systems of the two leading countries of Europe which pay the closest attention to elementary schools. Published by C. W. Bardeen, Syracuse, N. Y.

A valuable and well-arranged manual of the *Geography of Africa South of the Zambesi*, with notes on the industries, wealth, and social progress of the states and peoples, by *William Parr Greswell*, is published by a London house which is represented in New York by Macmillan & Co. The author alleges as a reason for the being of his work that the country is marked by the display of the power of European colonization. It "has ceased to be a country of mere sporting adventure or of aimless wanderings. It is gradually being identified with the European system; and by recent international conventions and agreements, under the Salisbury Government, boundaries have been assigned and frontiers surveyed which are likely to be permanent and beneficial to all contracting parties on the east as well as on the west coast." A large proportion of the space is taken up with the account of Cape Colony as the largest of the colonies and countries, and as having many features common to all. Maps are given of Cape Colony, Natal, and British South and Central Africa. Price, $2.

Mr. *W. Lee Beardmore*, author of *The Drainage of Habitable Dwellings* (Macmillan & Co., $1.50), has for many years past made a special study of the science of house drainage. In writing the articles, for British technical journals, of which the book has been composed, he touched briefly upon what has been done in an insanitary manner in the past, and pointed out what should be done to render a dwelling thoroughly sanitary in its drainage arrangements. While some critical readers may think he has not gone deep enough into the theory or into the practice, he hopes he has made a hearty endeavor to place before the public what should be done in order to have a truly habitable dwelling.

In *Humanity in its Origin and Early Growth* (Open Court Publishing Company, Chicago, $1.50), the author, *E. Colbert*, has endeavored to trace out a few of the salient points in the early unfolding of man and his thought, principally in those ages which preceded the writing of history; to show some of the states of development by which man was evolved from merely inanimate matter, and more especially those by which he rose from the level of his immediate predecessor in the scale of progress; then to sketch the widening out of the human mentality from the infantile phase to that of the child in knowledge, at which point it is left for history to take up the thread of the narrative. The principal object has been to discover primitive ideas about the causation of events and the constitution of things, and to show that to a great extent man's religious creeds and ceremonies, with much of his philosophy, grew out of notions which appear to have been first entertained as a result of observing the stars.

The first number has appeared of the *Journal of the United States Artillery*, published under the authority of the staff of the Artillery School. As the name of the journal implies, it is devoted to the interests of the artillery. The present number contains articles on sea-coast guns and steel armor, field practice, the English proving-grounds at Shoeburyness, the determination of the velocity of projectiles by sound phenomena, book notices, and abstracts of the contents of service periodicals.

The Department of Agriculture publishes a *Report on the Agriculture of South America*, with maps and the latest statistics of trade, which has been prepared under the direction of the statistician, *Almont Barnes*, a gentleman whose long residence in South America as United States consul, and subsequent study of the condition and progress of the South American countries, well qualify for the work. The several countries of the continent are considered each in its separate chapter, with discussions of all the points connected with the general subject.

A preliminary report on *Timber Physics*, compiled by *B. E. Fernow*, chief, and published by the Forestry Division of the Department of Agriculture, contains ample statements concerning the purpose, theory, and practical application of the timber tests

now being made in the forestry division, of which a number of brief notices have already been given. The headings under which the subject is treated include the "Need of the Investigation," "Scope and Historical Development of the Science of Timber Physics," and "Organization and Methods of the Timber Examinations in the Division of Forestry."

The *Psychological Table* prepared by Prof. *W. R. Benedict*, of Cincinnati, on the basis of the teachings of James Ward and Prof. Höffding, presents on a single sheet at one view the whole course of the development of consciousness, feeling, and thought. Defining psychology as the science of consciousness, it assumes that consciousness is dependent on nerve matter, and therefore starts with affections of that. There are presented the beginnings of consciousness; its development by differentiation; sensation and the senses; representation, or the return of states of consciousness; intellection, or thought; feeling; the will; and psychical disease, the progress of which, in contrast with evolution, is called devolution.

From the annals of the Astronomical Observatory of Harvard College is reprinted a valuable compend of the *Investigations of the New England Meteorological Society* for 1890. Reports were received from 172 different observers, but owing to various changes the average number of observers was about the same as in 1889—194. There are room and need for more observers in western and northern New England. In reviewing the cyclone observations of the year, notice is taken of the course of the storms, and as far as practicable of the relations to other regions of those which passed through it and north and south of it. In the work of gathering climatic data, the attempt to prepare such general results as isothermal maps or maps of mean annual rainfall has been met with the two difficulties of an insufficient number of reporting stations, and of insufficient time since the stations have been established to afford trustworthy means for a climate so variable as that of New England. The society hopes in time to be able to attempt the preparation of tables and maps that shall portray the peculiarities of local climate on a finer scale than that which suffices very well for the country as a whole. A careful study of the tornado at Lawrence, Mass., of July 26, 1890, is given in papers by W. M. Davis, director of the society, and H. Helm Clayton, of the Blue Hill Observatory.

A pamphlet entitled *Humanity's Spreading Curse* is aimed at the exposure of the "Scribes and Pharisees," by *One of them*. The characters held up to reprobation are: "The Common Scribe," "The Moral Scribe," "The Puritan," "The Foolism Scribe," and "The Pharisee"; the question is asked, "What must we do to be saved?" and quotations are made from newspapers and periodicals to enforce the author's points. The characters aimed at by the author are doubtless all liable to criticism; but criticism is one thing, and reckless denunciation is another.

The *Annual Report* of the Geological Survey of New Jersey for 1891 (*John C. Smock*, State Geologist) is full of valuable facts and statistical data concerning the resources of the State, and of suggestions for their further development. The work of the survey was carried on during the year in the study of the surface or Pleistocene formations in the northern part of the State; in an examination of the oak-land and pine-land belts of the southern part of the State; in the continued study of the stream-flows and water-sheds for the report on water-supply and water-power; and, in co-operation with the United States Geological Survey, in the study of the crystalline rocks of the highlands of northern New Jersey. In addition to a very satisfactory presentation of these subjects, articles are given on "Artesian Wells," "Passaic River Drainage," "Iron Mines," and "Mineral Statistics." The detailed study of the drift and of the glacial moraine and its topographical characteristics is full.

A convenient manual of the *Elements of Materia Medica and Therapeutics*, compiled from the British Pharmacopœia of 1885, and its appendix of 1890, by *C. E. Armand Semple*, is published by Longmans, Green & Co., New York ($3). While it treats in the main only of the drugs that are official, a few illustrations of non-official plants have been introduced here and there, in order to demonstrate some particular facts. The book is divided into two sections: the organic, dealing exclusively with the vegetable and ani-

mal products; and the inorganic, containing, besides inorganic substances proper, alcoholic and ethereal preparations, creosote, paraffin, etc., and carbon products generally. Stress is placed upon the illustrations—of forms of crystals and representations of plants—as tending to make the subject more interesting and to impress the facts more firmly upon the memory.

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Ball, W. W. R. Mathematical Recreations and Problems. London: Macmillan & Co., 1892. Pp. 241. $2.25.

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Bendire, Charles. Life Histories of North American Birds. Washington: Smithsonian Institution, 1892. Pp. 446. Illustrated.

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## POPULAR MISCELLANY.

**Moral, Manual, and Science Training in the Boston Public Schools.**—The report of Mr. Ellis Peterson, of the Board of Supervisors, on the Revision of the Courses of Study in the Boston Public Schools, begins with a notice of the rules concerning moral teaching. Teachers are expected to give instruction for a few minutes in good manners and good morals at the opening of the school, and at other favorable opportunities, avoiding sectarian subjects. Conversations and written exercises on good manners and good morals are prescribed for the upper classes. Referring to the standard of proficiency in scholarship, the report advises, that instead of considering absolutely what the pupil has accomplished, when the naturally brightest one will easily carry off the reward, the teacher should look to relative ability, and commend those who have done their best. Physical training is given through the Ling system of gymnastics. Manual training appears in the course of study for the first time. The principle on which it is given is represented in the sentence, "All drawing should be the expression of facts which they have been led by their teacher to observe in solid forms." The observation of Nature, plants, and animals by pupils is closely followed by lessons in manual training; while drawing and oral and written language are used to express the results of observation and manual work. The work of observation begun in the primary schools is continued, under the name of elementary science, in the grammar schools. The first line of work in this direction is in physiology and hygiene. Books have to be depended upon for this study, and their statements taken upon trust. "The information thus gained is of little educational value, but is believed to be of great practical use." The second line of science work is in the direction of natural history. The observation of animals, plants, and minerals is continued. Pupils are expected to study plant-life with the help of window gardening, or a school garden; to collect specimens of grains, woods, pressed leaves, and wild flowers, and of some typical animals, plants, and minerals; and to learn the relation of mineral, vegetable, and animal products to arts, industries, and commerce. The third kind of science-work required by the course of study is the observation of physical phenomena. The educational value of these lines of science-work is in proportion to the degree in which the method of work is observational, inductive, and systematic.

**Muir Glacier, Alaska.**—Muir Glacier, Alaska, as described by Harry Fielding

Reid, in his Studies of its features (National Geographic Society, publishers), occupies a depression in the mountain about thirty-five miles long and between six and ten miles wide. It is fed by a great number of tributaries, the largest of which are again made up of many smaller glaciers. A total area of about eight hundred square miles is drained by the system, and the actual surface of the ice is about three hundred and fifty square miles. The area draining into Muir Inlet is about seven hundred square miles. Most of the precipitation which falls on this area flows off as water in the subglacial streams; the rest, compressed into ice, is forced through the narrow gateway two miles and a half wide into the inlet, where the glacier terminates in a vertical wall of ice varying from one hundred and thirty to two hundred and ten feet above the water surface, whence large masses are continually separating to become icebergs. The water is in places seven hundred and twenty feet deep, and, as this is not enough to float a mass of ice rising so high above the water as the glacier, the ice must reach to the very bottom and must attain a thickness of nine hundred feet. The actual length of the ice-front facing the water is nine thousand two hundred feet, or a mile and three quarters. On each side the glacier sends forward a wing, which rises in the shape of a wedge over the stratified sands and gravels of the shore. The wings are fringed by treacherous quicksands, which support large stones and look firm; but the tourist who steps on them carelessly will sink in over his ankles. The ice-front has a wonderful coloring. Places from which ice has recently broken off are deep blue, sometimes almost black. This color lightens under exposure to the air and sun, and in a few days becomes pure white. All shades of blue, in striking variety, are represented in the ice-front.

**The Action of Fungicides.**—The principle involved in the use of fungicides for plant rusts, according to Prof. Byron D. Halsted, in the Report of the New Jersey Agricultural Experiment Station, consists in the application to the susceptible plant of a fine spray containing the substance that, when in contact with the spores, will either kill them or prevent their development. The whole practice of using fungicides depends upon the fact that these mildews, rusts, blights, and other fungous decays produce minute spores, which are easily disseminated and thereby propagate the trouble far and wide. These spores, either as such or when undergoing germination, are easily injured by various chemicals, notably the compounds of copper. It therefore follows that if these fungicides be placed upon the foliage in a thin film, it will go far toward destroying the spores already there and prevent those subsequently falling upon it from germinating. The ways in which this principle is carried out are many, depending upon the nature of the infected plant. The progress made during the last ten years in the study of fungous diseases is unparalleled. A few workers began collecting and describing some fifty years ago. This was followed a quarter of a century later by a critical study of the injurious species. The first systematic tests of fungicides do not date back more than a decade ago, and since that time, through the Department of Agriculture, experiments were begun which have been continued with well-defined practical results. By means of the experiment stations a new impetus was given to the subject about three years ago, and to-day there is a well-organized crusade against the fungous enemies of crops. The nature of the several blights, molds, and rots has been studied out in the laboratory, while fungicides in large numbers have been tested in the field. The result has been that several of the worst are practically subdued, provided the methods of warfare are followed.

**Shuswap Traits.**—Among the customs of the Shuswap people of British Columbia recorded by Mr. George M. Dawson is one from primitive times, by which, in the case of a man dying and leaving behind him a widow or widows, his brother next in seniority took the widow to wife. The right of a man to the widow of his deceased brother was considered as incontestable as that to his own wife or wives, and the women had equally a claim to receive from him the duty of a husband. The proper name of a man was changed from time to time during his life, when he would assume the name of some kinsman. Young men on reaching manhood were accustomed to separate themselves and

go away alone into some solitary part of the country, where they would often remain for three or four months. They might hunt or trap, but must avoid contact with other people and keep away from habitations. Occasionally a young man thus engaged would clear a course in the woods or arrange bars for running or for jumping, and thus endeavor to increase his strength and endurance. They also meditated and dreamed dreams till each discovered his particular guardian spirit. Young women, at the time of reaching maturity, and thereafter at recurrent periods, were accustomed to wander forth alone after dark for considerable distances, breaking small branches from the trees as they went, and scattering them about or suspending them upon the limbs of other trees. Young fir trees, a few feet in height, were thus often split and torn apart for several feet, or the branches or growing tops were tied in knots. This custom still prevails, and the tokens of it may often be observed near Indian camps. No explanation of its meaning can be offered. An Indian who invited another to go hunting with him, gave to his friend the first deer, if several were killed. If but one was killed, it was divided, but the skin belonged to the friend in any case. If a man was hunting beyond the border of the recognized territory of his people, and one of the men holding claims to the region upon which he had thus trespassed heard him shoot, the owner of the locality would head for the place, and on arriving there expect to be feasted on the game obtained by the hunter.

**Origin of the Jardin des Plantes.**—According to M. Germain Bapst, in the *Revue des Deux Mondes*, the Jardin des Plantes, in Paris, was till the middle of the eighteenth century simply a botanical institution which had been created by Louis XIII in favor of his Doctor Hérouard, under the name of *Jardin des plantes médicinales et potagères*. When Buffon was appointed steward of the garden by Louis XV, he augmented its service, founded a course of lectures and a museum of zoölogy, and continued the collection of miniatures of the Duke of Orleans. On his death, in 1788, the Museum of Natural History was far less important than it is now; the rapid growth which has made it the most complete and extensive establishment of its kind in the world, began during the Revolution: First, the Royal Menagerie, which had been kept in the garden of the Château at Versailles, was sent to the members of the Commune in Paris, in 1792. They, not knowing what to do with their new charges, sent them to the *Jardin des Plantes*, with orders to the steward to accommodate them there. That was the beginning of the menagerie. The other collections originated in the custom of the princes and great lords of the eighteenth century of interesting themselves in natural history and collecting objects of different kinds. Then, when the confiscation of the estates of absconders was decreed during the Revolution, there were found in them various collections of this kind. These were turned over to the state and were deposited in the public storing-places, especially in the *Jardin des Plantes*. The French conquests throughout Europe gave them possession of numerous museums which their generals removed to Paris and placed in the national establishments. Thus the collections of the Stadtholder of Holland, and that of the Prince of Condé, kept at Chantilly, came to constitute the physical and mineralogical departments of the museum.

**Variety of Motions in the Atmosphere.**—Espy's convection theory of storms assumes that the latent heat of vapor is the maintaining power, while the original ascent of the moist, warm air is due to conditions of density. Therefore, we could have no cyclonic motion without ascending moisture and clouds. The studies of other investigators have satisfied Prof. Cleveland Abbe that another important cause exists in the slow cooling by radiation and descending of the upper air flowing northward from the equator as a return trade. It eventually reaches the earth here and there in spots which are small areas of clear sky in the tropical regions, but are large areas of cold, dry air and high pressure in northern latitudes. "If the air is cooled by radiation faster than it is warmed up by the compression of its slow descent, then it reaches us as clear, cold, and dry air; and only after reaching the earth's surface does it begin to warm up in the daytime faster than it can cool again at night.

As this dry cold air underruns the moist warm air at the earth's surface, or as two areas of high pressure flowing toward each other must lift up the lighter air between them and set it into cyclonic rotation, we must, therefore, recognize the general conclusion that Espy's aspiration cyclone as developed by Ferrel is not the only form of cyclone, but that those due to descending cold air, and, therefore, having the general circulation of the atmosphere as their fundamental cause, are equally entitled to consideration. To this last and latest development from the theoretical side, I need only add that the study of the motions of the clouds has enabled me to assert that there is no form of motion known to the student of mechanics of fluids but what is to be found beautifully illustrated in some important phenomena of the atmosphere. The experiments on the motions of water and of air, and the measurements thereon that you may make in a well-appointed physical laboratory, are repeated by Nature on a large scale in the atmosphere."

**Antiquity of the Wheelbarrow.**—The invention of the wheelbarrow has been generally ascribed to Blaise Pascal, who lived about the middle of the seventeenth century. M. Littré, in his Dictionary, attributes it to one Sieur Dupin, in 1669, seven years after Pascal's death. M. Gaston Tissandier, however, found in a copy of the Cosmography of Sebastian Munster, 1555, a curious woodcut representing a wheelbarrow pushed by a workman. Another plate in the same book shows a tramway wagon running on rails. Still earlier evidences of the existence of the wheelbarrow have been found by M. Bixio and M. F. Guerrero, who organized the retrospective exposition of the means of transportation, which was held at Paris in 1889. A manuscript history of the sangreal of the thirteenth century contains a picture of one man shoving another in a wheelbarrow of a style now in general use. A manuscript—*Vita et Passio S. Dionysii Areopagi*—of the fourteenth century, has a representation of a wheelbarrow of another model, which is used in carrying a bundle. A very artistic picture in a manuscript—*La Vie et les Miracles de Notre Dame*—of the fourteenth century, represents a hospital where Sisters are taking care of wounded, lame, deformed, or paralytic persons, to which a man is wheeling a new patient. A miniature in an illustrated edition of *Quintus Curtius*, of the fourteenth century, shows a workman wheeling building material, who is assisted in sustaining his load by a strap over his shoulders. These evidences testify to the use of the wheelbarrow as early as the thirteenth century, and it may have been an old invention then.

**Trees and Extreme Temperatures.**—The power of trees, says a note in Garden and Forest, to regulate their own temperature to a certain extent is seen in the fact that their twigs are not frozen through in winter; nor does their temperature increase in summer in proportion to the temperature of the surrounding atmosphere. The bark is a bad conductor of heat, and is to a certain extent the clothing in which the plant is wrapped. The surface evaporation of the leaves produces in summer a freshness in them that causes them to feel cool even on hot days. Evaporation, however, does not explain the coolness of many kinds of fruit that are inclosed in a hard envelope, through which it seems almost impossible. Hooker mentions a fruit grown by the Ganges in a soil having a temperature of from 90° to 104°, the temperature of the juice of which had only 72° Fahr.

**Liquid Air and Liquid Oxygen.**—A lecture was recently delivered at the Royal Institution, London, by Prof. Dewar, embodying the results of his recent investigations into the properties of matter at excessively low temperatures, and in particular of oxygen and atmospheric air in the liquid condition. The lecture was illustrated by experiments such as have never before been attempted in a lecture-room. Liquid oxygen was produced in the presence of the audience literally by pints, and liquid air was handed round in claret glasses. While oxygen boils in air at 182° C. below zero, the researches of Lord Kelvin and Prof. Tait indicate that temperatures below —274° C. will not suspend all the activities of matter. As this is far below even the calculated boiling-point of liquid hydrogen, the absolute zero seems to recede as we advance. The purely chemical rela-

tions of oxygen disappear in the liquid condition. Phosphorus or potassium may be plunged into the liquid without any sign of combination. But the magnetic properties of the gas are intensified, and the action of the liquid upon light is identical with that of an equivalent quantity of oxygen in the gaseous condition. But while thus strongly magnetic, liquid oxygen is an extremely bad conductor of electricity. The boiling-point of liquid air is 192° C. below zero, or 10° C. lower than that of oxygen. The doctrine of the text-books that the oxygen liquefies first and the nitrogen afterward is erroneous. Air liquefies as air; but the boiling liquid parts with its nitrogen first, and becomes gradually richer in oxygen. Both in appearance and in spectroscopic behavior liquid air is simply diluted liquid oxygen. The blue tint of the oxygen is lost, and the absorption bands in the red are proportionately faint. Were this globe cooled down to some 200° C. below zero, it would be covered with a sea of liquid air thirty-five feet deep, of which about seven feet would be oxygen.

**The Eleventh Census.**—In an address delivered before the American Statistical Association Robert P. Porter, Superintendent of the Eleventh Census, stated that sixty thousand persons took part in the work of this census, and that its reports will make not less than twenty-five quarto volumes of one thousand pages each. Of the thirty experts and chiefs of divisions, at least twenty-three held similar or prominent positions in the tenth census. By the use of the electric tabulating machine it has been possible for the first time to aggregate from the schedules all the information which appears in any way desirable. Taking warning from the fate of educational statistics in the tenth census, which largely failed of publication, it was determined to confine the inquiries in the eleventh census to a small number of essential questions most readily answered. The statistics of mortgage indebtedness was a novel feature of this census. Under this head was made only the simple inquiry whether the farm or home was owned or rented, and, if owned, whether free from debt or not. Although these and some other inquiries increased the cost and added to the difficulties of the constitutional enumeration, the superintendent is confident that the work did not thereby suffer to any serious extent. In conclusion, Mr. Porter points out some defects of our census system, and urges a permanent Census Bureau.

**The First Cigars in Paris.**—Some interesting information has recently been published respecting the time when cigars first came into use. A passage in Hippolyte Auger's *Mémoires*, now very rare, relates that "our return to Paris (in 1823) was made by way of Orléans. On the road we met quite frequently officers returning from Spain. They swaggeringly had cigars in their mouths —a new habit, which has since become general." Another document carries back the use of the cigar to a somewhat earlier date. The *Hermite de la Chaussée d'Antin* (vol. iv, 1813), going to call upon his nephew, a young officer on leave in Paris, found him at his hotel in morning costume with a black silk cap on his head, and smoked a Havana cigar with him. The taste for the cigar was so common at that time that grocers, alive to their interests, were accustomed to present them to their customers. A set of complimentary verses, composed by Armand Gouffé for the actor Chapelle, of the Vaudeville, who had added to his professional occupations dealing in colonial produce, included in the nomenclature of articles that might be obtained in his shop—

> "Gum, marshmallows, rum and rack,
> Barley-sugar, almonds, and cigars."

**Natural Selection among Egyptians.**—"In spite of what appears to us a meager bill of fare, the Egyptian fellah," says Prof. Robert Wallace, "is very often a man of splendid physique, superior in strength and in endurance to the Indian ryot, whom he strongly resembles in many of his ways of working, his habits, his stolid lack of nervousness, and the absence of fear of sudden danger to his person. It is believed that the fellahin are almost exact reproductions of their predecessors for generations, and that, although the country has been frequently conquered, the new-comers were insignificant in numbers to the mass of the people, and consequently became rapidly absorbed. It is also a common belief that the soil and climate, and possibly the Nile

water, exercise an influence in producing a certain type; for example, the nut-brown skin of natives of Lower Egypt. This is so, but the direction in which the influence works is frequently misunderstood. The result is more probably brought about by natural selection than by the modification in a given direction of the individual units of successive generations. Thus the negroes, though coming in numerously and intermarrying with the Egyptians, gain no ground, because the climate of the Delta is unfavorable to them, and they die of pulmonary disease within a few generations. Again, Europeans and strangers to the country generally suffer and die from typhoid fever in vastly greater proportions than the natives."

**Magnifying Glasses in Antiquity.**—Probably the earliest mention of magnifying glasses is quoted by Mr. Henry G. Hanks, in the Papers of the Astronomical Society of the Pacific, from the Vanity of Arts and Sciences of Henry Cornelius Agrippa, of the early part of the sixteenth century, where it is said: "So we read, as Cœlius in his ancient writings relates, that one Hostius, a person of an obscene life, made a sort of glasses that made the object seem far greater than it was; so that one finger should seem to exceed the whole arm, both in bigness and thickness." There is difficulty in fixing the date of Cœlius, but he probably lived before Livy; and Hostius was a still more ancient personage.

**Funeral Customs in New Guinea.**—The death of a chief recently gave the Rev. S. B. Fellows, one of the Wesleyan missionaries in New Guinea, an opportunity of observing the native funeral ceremonies, which are somewhat similar to those of the Maories. From the time of death until burial, the corpse lies on the floor of the house, with no other covering than it had in life. In the present case a man, a near relative, was seen lying across the corpse, which he hugged and stroked, with loud crying and bitter sobbing. The women kept up an unceasing wailing and crying, signs of a grief which seemed genuine enough. The virtues of this chief were chanted as the mourners repeated again and again the names of the islands he had visited in his canoe, the amount of food he had brought home, the fish and pigs he had caught, etc. Large fires were kept burning underneath and round the house during the night to scare away the "debil debil." On the morning of the second day after death, the body, wrapped in rough mats, was buried soon after sunrise, without any rites; and on that day a feast was made for the friends and mourners. An old cocoanut palm, of great value, is cut down, and the leaves are used for the roof of the small house that is built over the grave. At the funeral of a woman a yam was placed on each side of the head, and a native cooking-pot with the bottom knocked out was put on the head cap-fashion. A dish of cooked food is passed up and down the corpse before it is covered; and an annual offering is made at the grave. The soul of the dead person, called *barnaqum*, is supposed to linger near the body until it is buried; then it quietly takes its departure, by way of the mountains of Misima, for a place deep down in the earth, called *tuma*. Souls are permitted to revisit the earth, when their presence is made known by a peculiar low whistle. After remaining in *tuma* for a long time, they undergo a change similar to the death of the body, and are then transmigrated to the bodies of infants yet unborn.

**Development of Exotic Gardening.**—Charlemagne is called, according to the Gartenlaube, the first æsthetic gardener in western Europe; for he it was who took pains to transplant into German gardens the useful and ornamental plants that grew wild in the woods and the fields, and to introduce those which flourished beyond the Alps. As men increased in good living and their tastes became refined, they were not satisfied with useful plants alone, and the gardens of the more wealthy were adorned with the choicest ornamental and fancied plants of the East. The proverb, "Gardens are visiting-cards; what they are shows what their owner is," is illustrated in the history of the development of the German garden, which is really a chapter in the history of civilization. With great extension of trade in the beginning of the sixteenth century, rich acquisitions were made to gardens from all foreign countries—a process of growth which has not yet ceased, but seems to be

going on more actively than ever. Prof. G. Kraus has well said that, if some giant hand should remove at one stroke all the plants which have not grown native among us from time immemorial, our gardens and large spots in our cultivated fields would be reduced to the condition of deserts. From the annals of the botanical gardens, beginning with the establishment of that of the University of Padua, in 1545, an important chapter could be gathered in the history of the migrations of plants. A few American guests appeared there about the middle of the sixteenth century, which were at first called Indian or Spanish plants. Among them was the *Papas peruanorum*, which was cultivated as an ornamental plant without a suspicion of its coming destiny—the potato. There were preferences among the strangers, and the fashions changed; Oriental bulbs were succeeded by Canadian plants, among which the Robinia, or locust, the Virginia creeper, asters, and evening primrose, were high in favor. Then came greenhouse plants from the Cape of Good Hope —scarlet pelargoniums, dracænas, charming heaths, and others, which are still in favor. American trees were then sought for park plantations, with the crab-apples and flowering shrubs of Siberia. After these improved commercial facilities favored the introduction of the curious eucalypti and other plants of Australia; botanists are traveling everywhere with their Wardian cases, collecting and bringing safely home the rarest and most delicate orchids and palms of the tropical forests, and plants of every region where vegetation flourishes. About 1,500 species of plants grow wild in England. In 1891 there were cultivated in the botanical gardens at Kew 19,800 species and varieties; in Berlin, in 1890, 19,000 sorts; and in St. Petersburg, 25,000 varieties with 71,850 specimens.

**Chinese Characters and Hieroglyphics.**—In a paper on the social and religious ideas of the Chinese, as illustrated in the ideographic characters of the language, Prof. R. K. Douglas shows that the Chinese ideographic characters are picture-writings, and as such supply an interpretation of the meaning of words as they were understood by the inventors of the characters representing them. These characters, developed from the original hieroglyphic forms, were considered illustrative of the ideas of the people on political, social, scientific, and religious subjects. For example, the importance attached to the qualities of the sovereign is exemplified in the choice of the symbol employed to express a supreme ruler, the component parts of which together signify "ruler of himself." By means of the same graphic system a kingdom is shown as "men and arms within a frontier." The domestic life is illustrated by ideograms descriptive of household arrangements and relationships. The speaker in succession traced in the written characters the ideas associated with men and women—their virtues and failings; the notions associated with marriage; and the evidences of pastoral and agricultural habits among the people. The discussion of the popular religious faiths showed how prominent is the belief in the god of the soil, whose presence brings blessings, and whose averted countenance is followed by misfortunes.

**Death-week in Rural Russia.**—Some very curious ceremonies are observed by the peasants of rural Russia, on the breaking up of the ice toward the end of March. The breaking is supposed to be due to the water-spirit, who, waking hungry and angry after his winter's sleep, bursts the ice and sends the floes drifting, drives the fish from their haunts, and causes the streams to overflow. Previous to this the peasants prepare a sacrifice as the beginning of their "death-week" celebration, to be offered to the spirit. They combine to buy a young horse, which must be purchased, not given, each contributing an equal amount. The horse having been sumptuously fed for three days, is taken on the fourth day at midnight, decorated, conducted by all the villagers in a body, tied, weighted, and plunged through a hole in the ice. In some districts fat, in others a horse's head, is thrown in instead of a living horse. A sacrifice is then made to the house spirit. A fat black pig is killed and cut into as many pieces as there are residents of the village, of which each resident receives one and buries it under the doorstep at the entrance to his house. The principal ceremony of the season is that of

driving out death. All the villagers bring old clothes, rags, straw, sticks, and other stuff of the kind, from which a dummy figure representing an old woman is made, and painted as hideously as possible, to represent death—death being a woman in Slavic mythology. The figure is perched on a long pole and carried by a peasant dressed in what are left of the rags, etc., who is accompanied by a procession of the people provided with everything with which they can make a noise. The dummy is carried to the nearest river or stream, and cast into the water, or sometimes only ducked, and then thrown upon the nearest piece of vacant ground, or sometimes cast into the territory of a neighboring village, when a quarrel is likely to arise. On returning to the village, more noisy instruments are collected, and the men, women, and children run round to drive out the evil spirits death is supposed to have left behind. The faster the people go, and the more noise they make, the more effectually the place is supposed to be cleared, and the greater will be the blessings of the coming season. To make all sure, the villagers camp out for the night, to wait for the hour when the gates of heaven are supposed to be opened, and special blessings asked for are granted. All the trees are said to bear golden fruits at that instant, and whoever is lucky enough to grasp them just then can keep them as his own. Unhappily, the people are always too wearied with the day's work and drinking to be alert enough to seize the exact moment.

**The New Stone Age in Iceland.**—According to a lecture before the English Society of Arts on Iceland, by Dr. Tempest Anderson, in the more remote parts of the country, such as the Skaptadals, many articles of bone and stone are still in use which in more accessible districts have been replaced by metal or earthenware. A photograph exhibited showed a wheelbarrow with a stone wheel, a steelyard with a stone weight, a hammer with a stone head, and a net with bone sinkers. At the same farm a quern, or stone hand-mill, was in use, and also horn stirrups, and harness fastenings of bone instead of metallic buckles, bone pins, and rude bone dice. At a neighboring farm was a basin formed of the cup joint of a basalt pillar. Truly we still have a survival of the stone age. Less remote than this is the meeting-place of the county council of the district in a spacious cave in the lava. It would be difficult to find anything more appropriate in such a primitive land. Mr. E. Magnusson, speaking on the author's address, said that in some places the people, though descended from those who had long left the stone age behind, had found it necessary, because it was so difficult to procure iron, to create a new stone age for themselves. They were the creators of a new stone age, not the followers of a tradition.

**Oxygen by the Brin Process.**—The manufacture of oxygen on a commercial scale is developing into a new and important branch of business enterprise. The process employed, called the Brin process, depends upon the property of barium monoxide of absorbing oxygen from the atmosphere when heated to about 1,000° F., and giving it off again at about 1,700° F. Barium oxide closely resembles lime, and is found combined in nature as heavy spar and witherite. The nitrate, commercially known as baryta, is used. In the preparation of oxygen, air is forced by pumps into retorts containing baryta, where the oxygen is absorbed and the nitrogen is allowed to escape. When sufficient air has been pumped in, and after an interval, the process is reversed, and the oxygen yielded by the baryta is pumped into a holder. It is sent out to consumers compressed to a pressure of eighteen hundred pounds to the square inch, in cylinders of steel, ranging in size from three and a half to five and a half inches in diameter, and from one to eight feet in length. It is used in laboratories, in various manufactures, in medicine, as a disinfectant, and in the calcium light.

**A Versatile Animal.**—Among the curious animals of the pampas, described by Mr. W. H. Hudson, in his Naturalist in La Plata, is a hairy armadillo, an animal that will live on almost everything, from grass to flesh; that catches mice and kills poisonous snakes, "and having killed them, cuts them in pieces and swallows as much as it needs. . . . It is much hunted for its flesh," says Mr. Hudson, "dogs being trained for the purpose; yet it

actually becomes more abundant as population increases in any district; and, if versatility in habits or adaptiveness can be taken as a measure of intelligence, this poor armadillo, a survival of the past, so old on the earth as to have existed contemporaneously with the glyptodon, is the superior of the large-brained cats and canines."

**Destruction of Quail and the Plague of Locusts.**—The great and fearful increase of locusts in Algeria is ascribed by the French journal *L'Éleveur* to wholesale destruction of quail by sportsmen. It is estimated that a quail consumes daily from fifty to sixty grammes of food, and that twenty tiny locusts of the size of a hemp-seed go to a gramme. Hence one quail may destroy daily 1,000 locusts, or from 20,000 to 25,000 during the period when the insects are small enough to be swallowed by it. The Tunisian sportsmen who on the 8th of May of last year shipped off 50,000 quails to France are, then, in a great measure to blame for 150,000,000 locusts less than usual having been destroyed by those birds during the year.

## NOTES.

THE portrait of William Bartram, referred to in the Popular Miscellany department last month, is inserted as the frontispiece of this number of the Monthly. A sketch of John and William Bartram appeared in our number for April, 1892.

A CURIOUS series of experiments on the hereditary transmission of mutilations has been made by Dr. C. G. Lockwood. By the in-and-in breeding of white mice for ninety-six generations he obtained a larger and finer animal than the original pair. In order to breed their tails off, he selected a pair and putting them in a cage by themselves and clipping their tails he got a breed of tailless mice in the seventh generation. Then, by taking one with a tail and one without a tail, and alternating the sexes in each generation, he finally again got a breed of all-tail mice.

IT results from the researches of Mr. C. M. Pleyte, of the Ethnological Museum at Amsterdam, that the use of the *sumpitan*, or blow-pipe, and of the bow, is separated by a line corresponding with that which distinguishes between the western and the eastern branches of the Malayo-Polynesian languages. The *sumpitan* is found nowhere to the east and the bow only sporadically to the west of the boundary. It is ingeniously argued that the blow-pipe was the primitive instrument, from the fact that it survives as a toy where it has ceased to be a weapon.

THE debate on the fitness of aluminum to be used in food-vessels is continued, with the report of the experiments of M. Balland. He discredits the representation that it is too readily corroded by many food-substances, and finds that air, water, wine, beer, cider, coffee, milk, oil, butter, fat, etc., saliva, and other substances have less action upon it than on such metals as copper, lead, zinc, and tin. Vinegar and sea-salt attack it, but not violently enough to make its use hazardous.

THE works of Prof. Wilhelm Weber, the physicist, are to be published by the Royal Society of Science at Göttingen.

THE optically inactive form of tartaric acid, known as racemic acid, has been obtained by M. Gensesse as an eventual product of the action on glyoxalic acid—an acid found in gooseberries, grapes, and other fruits—with nascent hydrogen liberated from a mixture of zinc-dust and acetic acid.

A FUND, called the De Laincel fund, has been dedicated to the promotion of the study of the graphic system of the ancient Mayas, by collecting vocabularies and obtaining reproductions of the mural inscriptions of Central America and of their manuscripts. The work will be carried on under the direction of a committee of recognized qualifications; and the explorations will be directed by Dr. Hilborne T. Cresson, of Philadelphia, an experienced ethnologist and a Maya student.

A NOVEL view of the puma, or panther, as it is commonly called, is taken by Mr. W. H. Hudson, in his Naturalist in La Plata, who insists that it never attacks man except in self-defense. In the Pampas, where it is common, the *gaucho* confidently sleeps on the ground, although he knows that pumas are close by; and it is said that a child may sleep on the plain unprotected in equal security. This is not on account of fear or dislike of man, but of an apparent cat-like fondness for being near him. The *gauchos* call the animal "the friend of man."

INTEREST in stilt-walking — concerning which we published an illustrated article several months ago—has been revived by a stilt-walking match which was contested on the 27th of May last, under the auspices of the journal La Gironde, of Bordeaux, France. The course, from Bordeaux to Biarritz, 257 kilometres, was passed over by the victorious contestant in 55·30 hours, or at an average speed of 4·650 kilometres per hour. This is not much if any better than could be done by an ordinary walking-match pedestrian.

REMAINS of a mammoth and other prehistoric animals have been found in Endsleigh Street, London, at a depth of twenty-two feet below the surface. They include two tusks nine or ten feet long, one of which is two

feet in circumference at its thickest part, and a lower jaw and other bones of a younger mammoth. The seeds of about twenty species of contemporary marsh-growing plants have been found in the soil in which the remains were imbedded.

THE American Metrological Society has prepared a petition asking Congress to order the metric system to be used exclusively in the customs service in the United States. The Geographical International Congress at Berne, Switzerland, last year, entreated English men of science in future to use only the units of the metric system in scientific and technical publications. The new Decimal Association in London has petitioned the proper authorities to prepare alternative questions, based on the metric system, to be used at the option of the candidate in the May examinations of the Science and Art Department.

A NOVEL and interesting feature of the first United States Food Exhibition to be held in Madison Square Garden, New York, in October, will be a national exhibit of dairy products. It will be in charge of Prof. James Cheeseman, a recognized dairy expert and authority in all matters pertaining to dairy interests, who represented the United States in that department at the late Paris Exposition. He is also known to our older readers by his suggestive article on Selection in Grain-growing, in The Popular Science Monthly for July, 1883.

WE are informed by the Rev. Stephen D. Peet of the existence of three considerable collections of cave-dwellers' relics in the West—one in Denver, one in Chicago, and one in the far West. The relics in the collection of the Rev. Mr. Green in Chicago were carried two hundred miles on horseback, from Grand Gulch in Utah, a distant and retired branch of the San Juan Valley.

DR. CYRUS THOMAS announces in Science that he has at last discovered the key to the reading of the Maya Codices, and probably of the Central American inscriptions. The progress of decipherment will be slow, but, the clew having been obtained, it will ultimately be accomplished. The author has already determined the signification of some dozens of characters, and has in several instances ascertained the general sense of a group forming a sentence.

A REMARKABLE ice-cave or well, at Creux Percé, near the village of Pasques, department of Côte d'Or, France, is described in *La Nature* by M. E. L. Martel. It opens horizontally in the field, is fifty-five metres deep, with a mouth forty metres by twenty, and about two thirds of the way down narrows abruptly like a funnel to ten metres by five. The ice in the bottom is plainly visible from the top. On descending, which M. Martel did very easily with a ladder, the cave is found fringed with stalactites and stalagmites of ice from ten to fifteen metres long, and six or eight by two or three metres thick. The light at the bottom is sufficient to permit the ice to be photographed.

CARNABA WAX is a substance which has been used lately for hardening paraffin and making it less fusible, for improving the quality of the inferior kinds of beeswax, and in making candles, varnishes, encaustics, etc. It is derived from the palm tree known as *Copernica cerifera*, of Brazil, and is therefore sometimes called Brazil wax. It is very hard, breaks up into sharp-angled pieces under the hammer, and is yellow, gray, red, or maroon in color.

## OBITUARY NOTES.

ADMIRAL ERNEST A. B. MOUCHEZ, a distinguished French naval officer and astronomer, has recently died, in the seventy-first year of his age. His scientific career began with hydrographic and coast-survey work. He had charge of the French expedition to the island of St. Paul to observe the transit of Venus in 1874, concerning which he read a report before the five academies in 1875. In 1878 he succeeded Le Verrier as Director of the Paris Observatory. Having already organized at Montsouris a school of astronomy for officers of the marine and travelers, he carried out the same idea on a more extensive scale at Paris; and for eight years past his school has been a nursery of young astronomers for the French observatories. He also organized a curious and varied astronomical museum at Paris. He was honorary President of the Astronomical Congress which has met three times at Paris; and he is credited with having conceived the idea of the map of the sky in the making of which all civilized countries are now co-operating.

THE death is announced, at Buenos Ayres, May 2d, of Hermann Burmeister, the dean of South American naturalists, aged eighty-five years. He was of German birth, was Professor of Zoölogy at the University of Halle, and took up his residence in South America after having made several voyages there. Since 1861 he had been Professor and Director of the Museum of Natural History of Buenos Ayres, and Curator of the University of Cordova. Besides several works of natural history published in Europe, he was author of many important studies on the fauna and paleontology of South America, the most considerable of which were published in the Anales of the Public Museum of Buenos Ayres, a periodical founded by him, and of a Physical Description of the Argentine Republic. He is credited with having given an "enormous impulse" to science in South America, particularly in the La Plata countries.